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Confabulation and mood: a programme of studies

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**CONFABULATION AND MOOD: A
PROGRAMME OF STUDIES**

ANA BAJO

March 2011

**A thesis submitted to the Institute of Psychiatry,
King's College London for the degree of Doctor
of Philosophy**

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To my father (R.I.P.).

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ABSTRACT

The cognitive mechanisms which underlie the formation of confabulations remain a matter of debate. In the present programme of studies predictors of the presence and clinical course of confabulations, and affective biases in the content of confabulations, were examined.

24 confabulating brain injured amnesic patients, 11 non-confabulating brain injured amnesic controls and 6 healthy participants were assessed on confabulation, temporal context confusion (TCC), insight and mood measures. Confabulating participants were followed up for 9 months.

In partial replication of previous findings ([Schnider, 2008](#)), TCC scores were raised in confabulating patients compared with healthy individuals. However, TCC was not good at discriminating between confabulating and other brain injured patients. Current results are consistent with the argument that TCC may be sensitive, but not specific to confabulation ([Gilboa, 2010](#)).

A combination of poor insight and somewhat elated mood state predicted the *presence* of confabulations in the current sample sensitively and specifically. Initial elated mood score also predicted the *clinical course* of episodic confabulation. The present results indicated that elated mood and level of awareness into difficulties and well-being may influence 'core' mechanisms underlying confabulation ([Gilboa, 2010](#)).

True and false memories reported by patients were rated for affective content. Although many of them were evaluated as 'neutral', more confabulatory memories were labeled as either pleasant or unpleasant, than 'true' memories. Location of lesion in terms of whether focal ventro-medial frontal pathology was present or absent, had no effect on this affective bias. The affective state may contribute importantly to confabulation formation ([Fotopoulou, 2010](#); [Metcalf et al., 2010](#)).

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Chapter 1

Introduction

1.1. DESCRIPTION OF CONFABULATION

1.1.1. Definition

Confabulations are false memories, either because they are entirely or partially incorrect (for example, the event recalled is correct but the details of where or when it happened are incorrect), or because they consist of real memories jumbled up and retrieved out of context ([Kopelman, 2010](#)). The content of confabulated memories is usually autobiographical and unintentional; the patient is usually unaware of their condition ([Burgess and Shallice, 1996](#)). Confabulations often compel the person to act upon them ([Schnider, 2001](#)). Confabulation is a very debilitating condition: the person may self-discharge from hospital against medical advice, and social support networks are often further strained as relatives suffer unjustified paranoid accusations, and struggle to appreciate their unintentional nature.

1.1.2. Classification

Several classifications have been suggested ([Berlyne, 1972](#); [Feinberg and Roane, 1997](#); [Gilboa and Moscovitch, 2002](#)). Early classifications distinguished between 'momentary' confabulations (plausible confabulations based on reality) and 'fantastic' confabulations (without basis in reality, often with a grandiose theme) ([Berlyne, 1972](#)). The most widely used classification distinguishes

between 'provoked' versus 'spontaneous' confabulations ([Kopelman, 1999](#)). Provoked confabulations arise in response to a challenge (e.g. prompted by orientation or memory tests); whereas spontaneous confabulations arise in the absence of any external trigger and the person often acts upon them (for example a hospital in-patient may search anxiously for their uniform thinking erroneously they are on army manoeuvres).

More recently Schnider's novel classification distinguished behaviourally spontaneous confabulations from three other types of confabulation ([Schnider, 2008](#)):

- intrusions: described as 'simple provoked confabulations'
- momentary: plausible, semantic or autobiographical false verbal statements which may arise spontaneously during conversation or be directly provoked by questions
- fantastic: confabulations with no basis in reality; sometimes difficult to distinguish from elaborate momentary confabulations.

According to Schnider, behaviourally spontaneous confabulations appear without external trigger and in this way they differ both from false recognition during memory tests and from provoked confabulations, both of which arise in response to a cue. In addition, while provoked confabulations are associated with a variety of lesions and can happen even in healthy people, spontaneous confabulations are only associated with lesions in the orbitofrontal cortex (OFC) or anterior limbic areas connected with the OFC ([Schnider, 2003](#)). Behaviourally spontaneous confabulations are also different from fantastic and from momentary confabulations in that neither momentary nor fantastic

confabulations direct behaviour. Other authors have argued that there is no clear distinction between spontaneous and provoked confabulations: moreover, these often co-occur in the same patient ([Gilboa et al., 2006](#); [DeLuca, 2009](#)).

Features of behaviourally spontaneous confabulation

According to Schnider, the main characteristic of behaviourally spontaneous confabulations is that the person believes strongly in their confabulations and feels compelled to act on them. “For the patients, confabulations are the honest narrative of their perceived reality, rather than invented stories” ([Schnider, 2003](#)). In most cases the person is simply re-enacting an old habit ([Schnider, 2008](#); compare [Dalla Barba and Boisse, 2010](#)).

Confabulations can be traced back to true events ([Schnider, 2003](#)). Other themes, such as fantastic and semantic have been reported in patients with this syndrome, and reduplicative misidentification is often present, but these are not consistent features of spontaneous confabulations ([Schnider, 2008](#); [Kapur and Coughlan, 1980](#)).

The syndrome is also characterised by amnesia and disorientation. However, some confabulators have demonstrated normal memory function; orientation to person (i.e. one’s own identity) often resumes once the patient is out of the confusional state ([Schnider, 2008](#)).

Confabulating patients lack insight into their false memories, but may have limited awareness of other memory difficulties.

1.1.3. Differential diagnoses

Differential diagnosis of confabulation has led to intense controversy. Some authors distinguish between false recall and confabulation ([Schacter et al., 1998](#); [Gilboa and Moscovitch, 2002](#)). False recall usually refers to non-personal information studied post-insult, whereas confabulations usually refer to pre-injury autobiographical knowledge; although confabulations about semantic material or general knowledge have also been observed ([Dalla Barba et al., 1999](#)); [Kopelman et al., 1997](#)).

The differential diagnosis between confabulations and delusions remains unresolved. Some authors think confabulations are best understood as disorders of memory, whereas delusions are viewed as disorders of thought ([DeLuca, 2000, 2009](#); [Kopelman, 2010](#)). Other authors suggest they share underlying cognitive deficits; ([Johnson and Raye, 2000](#); [Turner and Coltheart, 2010](#); [Fotopoulou, 2010](#)). Spontaneous confabulations are often not amenable to change; on this basis it has been proposed recently that they are best viewed as delusions, and therefore only provoked confabulations qualify as genuine confabulations ([Coltheart and Turner, 2009](#)). Conversely some authors have proposed that only spontaneous confabulation constitutes the specific neurological syndrome observed in clinical populations; in this way they have argued it differs from provoked memory lapses, which can occur in the general population ([Kopelman, 1999](#); [Schnider, 2008](#)).

The aetiology of confabulation is varied; the syndrome has been observed following anterior communicating artery aneurysm, tumours, encephalitis, traumatic head injury and Korsakoff syndrome (Schnider, 2008). In addition, confabulations have been observed in the context of schizophrenia (Nathaniel-James and Frith, 1996), degenerative disease (Dalla Barba et al., 1999), and confusional states (Kopelman et al., 1997; Box et al., 1999). However, spontaneous confabulatory errors are often distinguished from lapses arising from confusional states (DeLuca, 2000; Schnider, 2008).

1.1.4. Brain pathology

Most authors view the ventromedial prefrontal cortex as the critical area associated with spontaneous confabulation (Gilboa and Moscovitch, 2002). Schnider (2008) has argued that the critical area is specifically the orbitofrontal cortex (OFC) or areas directly linked to it. Medial ventro-caudal (Brodmann Area 25 (BA25)) and basal forebrain have also recently been associated with 'confabulatory type errors' (Turner et al., 2008b). The medial rostral prefrontal cortex (PFC) (BA 9/10) has been found to be critical for remembering self-generated material (Turner et al., 2008b). Evidence derived from PET scan investigations also pointed to BA13 and BA10 as crucial areas for monitoring outcome, an essential mechanism underlying confabulation (Schnider, 2008; Schnider et al., 2005; compare Moscovitch and Winocur, 2002).

1.2. EARLY EXPLANATIONS AND THEORETICAL MODELS OF CONFABULATION

Many models have attempted to explain the underlying psychological mechanisms that are critical in the appearance of confabulations. At present at least three types of hypotheses are being followed: 1. the 'temporality' hypothesis, 2. the 'strategic retrieval' hypothesis, and 3. the 'motivational' accounts ([Kopelman, 2010](#)).

Current models of cognitive mechanisms underlying confabulations have their basis on early explanations. The following cognitive mechanisms were identified in early models as critical factors underlying confabulation, either separately or combined: memory deficit; chronological disturbance; 'gap-filling'; impaired monitoring and personal predisposition. These are reviewed in turn next.

Temporality accounts

Early models proposed that confabulations were a function of a basic amnesic deficit coupled with a distorted sense of time. This explained why confabulators often think past events are occurring in the present. For example Korsakoff (1889, cited in [Kopelman, 1999](#); [Schnider, 2008](#)) observed that confabulations were often based on the person's past events and prompted the patient to act upon them. He explained confabulations as a source monitoring deficit. He believed recent memory traces were weaker than those of remote memories, which made the latter easier to retrieve. Without a way of telling whether the memory belonged to the past or to the present, old memories were taken for

new ones ([Schnider, 2008](#); [Kopelman, 2010](#)). The early models were based purely on clinical observation, but the ‘distorted temporality’ hypothesis was later developed by several authors, who have provided more detailed explanations based on well-controlled experiments ([Schnider, 2008](#)). Temporality models make specific claims regarding both the appearance and the course of confabulations and are reviewed below in relation to this study’s investigations into potential predictors of a) the presence and b) the clinical course of confabulation.

Strategic accounts

Other early authors (e.g. Korsakoff, Kraepelin and Tiling) noted that in order for confabulations to appear there must be a monitoring deficit that allows incorrect memories to be outputted as correct ([DeLuca, 2009](#); [Schnider 2008](#)). These early models, which focused on ‘dysexecutive’ deficits underlying confabulation, were also developed later into more detailed explanations: the ‘strategic retrieval’ hypotheses ([Burgess and Shallice, 1996](#); [Gilboa and Moscovitch, 2002](#)). These models are primarily concerned with deficits in either memory specification, formation and/or verification processes that give rise to confabulations. These models provide a comprehensive explanation regarding a) the appearance, b) the clinical course and c) the content of confabulations and are discussed below regarding these three issues examined by the three investigations that form the current programme of studies.

Motivational accounts

Several early authors had noted certain personality traits or characteristics seemed to make some people more prone to confabulations than others. For example Van der Horst believed confabulations were motivated by the person's wishes (cited in [Berlyne, 1972](#)). Berlyne believed that in the absence of the real memories being available, 'fantastic' confabulations were produced based on fantasies with strong affect ([Berlyne, 1972](#)). Pick proposed that suggestibility as a consequence of trauma would create a predisposition to fill memory gaps with plausible information (cited in [Berlyne, 1972](#); [Schnider, 2008](#)). In 1938 Williams and Rupp proposed that confabulation was a function of several factors: memory deficit, lack of insight and a particular personality pattern, which included a tendency towards introversion. This personality pattern exacerbated suggestibility (cited in [Berlyne, 1972](#)). Yet a different explanation was suggested by Zangwill in 1953, who proposed that confabulation was part of a maladaptive response to illness: a kind of denial. Confabulation acted as defence mechanism against a potential 'catastrophic reaction' (cited in [Berlyne, 1972](#)).

The third type of current models, the 'motivational' hypotheses have derived from the above early explanations, and are concerned primarily with emotional factors underlying the appearance of confabulations ([Fotopoulou, 2008](#)). They are "complementary" to the 'temporality' and 'strategic retrieval' models: they do not make claims about the appearance of confabulations per se; instead they attempt to explain the emotional factors that influence the content of confabulations. Well-controlled experiments suggest that the content of confabulations may be driven by personal meanings, goals or wishes. These

models are reviewed below in relation to the present investigation into the affective content of confabulations.

Early hypotheses based on personality factors were not without criticism. In 1961 Talland rejected these explanations. He proposed that only plausible autobiographical false memories qualified as confabulations, since more fantastic fabrications could be attributed to delusion (cited in [Schnider, 2008](#)). Talland ([1965](#)) noted that the source of these confabulations were past personal autobiographical events. He also observed that in confabulations, typically, a memory of a past event was represented as a present event, but he did not consider this as the main cause of confabulations. Instead he viewed disturbed temporality as secondary to an amnesic disturbance. Personal dispositions or characteristics would then determine the presence, rate and quality of confabulations. Talland proposed the following characteristics of confabulation (cited in [Burgess and Shallice, 1996](#)):

- they are a coherent account concerning the patient;
- they are false statements;
- they have autobiographical content;
- this content is reconstructed, recombined and modified according to mechanisms of normal remembering;
- the person lacks awareness of the distortions;
- confabulations are unintentional and do not act as compensation for anything.

Executive dysfunction

More recently several authors have suggested that executive dysfunction could explain confabulation independently of amnesia ([Kopelman, 1987](#); [Kapur and Coughlan, 1980](#); [Benson et al., 1996](#)). Two patients underwent a neuropsychological assessment before and after they recovered from confabulation. At re-test both patients showed improvement on executive tests in parallel with decreased confabulations, but their amnesia scores remained unchanged at the severe level of function. The authors concluded that frontal control dysfunction, and not amnesia, was the critical deficit associated with confabulations ([Kapur and Coughlan, 1980](#); [Benson et al., 1996](#)). However, this hypothesis has been criticised ([DeLuca, 2009](#)). For example, behavioural experiments indicated that executive dysfunction did not distinguish between spontaneous confabulators and other amnesic patients, nor did it parallel recovery from confabulation ([Schnider, 2003](#)). In addition, confabulation has been described in the absence of executive dysfunction ([Burgess and Shallice, 1996](#); [Johnson et al., 1997](#); [Dalla Barba et al., 1999](#)).

Reduced awareness of false memories

Limited insight into confabulations has been observed by many authors, but has seldom been measured formally (Tiling, Williams and Rupp, cited in [Schnider, 2008](#)). Early authors believed confabulations were conscious efforts to fill gaps in memory when the patient was too embarrassed to admit they could not answer orientation or memory questions (Tiling, Bonhoeffer, Kalberlah, Pick and Moll, cited in [Schnider, 2008](#)). However, more recently it has been

acknowledged that confabulating patients lack awareness into their memory deficits and therefore confabulations are unintentional and may be unconscious (Talland, 1965; Burgess and Shallice, 1996; Schnider, 2008; Gilboa, 2010; compare Dalla Barba, 2009). Other authors viewed confabulations as either denial of deficits or an unconscious defence mechanism against a potential catastrophic reaction, were they to realise the full extent of their predicament (Zangwill, cited in Berlyne, 1972; Flament, cited in Schnider, 2008).

Limited insight is a theme that runs through most theoretical models of confabulation, and yet the relationship between insight and confabulation has seldom been explicitly studied (Talland, 1965; Burgess and Shallice, 1996; (Schnider, 2008). The present programme of studies aimed to examine the relationship between insight and the presence and clinical course of confabulation.

1.3. CURRENT MAIN THEORIES OF CONFABULATION

1.3.1. Temporality models

Korsakoff, Tiling, Van der Horst and Talland had noticed disturbed temporality or chronology as a salient peculiarity of confabulation (Schnider, 2008; Kopelman, 2010; Talland, 1965). Two models have derived from early temporality explanations: a 'disturbed temporal consciousness' model and a 'temporal context confusion (TCC)' model. They are reviewed next.

1.3.1.1. Disturbed temporal consciousness

Disturbed 'temporal consciousness' is one of the current explanations for the appearance of confabulations ([Dalla Barba et al., 1999](#)). This model proposes the following explanation for confabulations. Confabulators may be aware of a personal past, present and future which is distorted. Temporal consciousness is strongest for well established knowledge. Consequently, when memory traces are weak, temporal consciousness is framed by more stable memories: semantic knowledge. Therefore, when prompted, confabulators are likely to answer with memories or plans corresponding to well rehearsed memories or habits ([Dalla Barba, 2009](#); [Dalla Barba and Boisse, 2010](#)).

Dalla Barba's model is unique in that it is the only explanation that proposes fully conscious mechanisms of confabulation. He criticises other models for putting forward explanations based on unconscious mechanisms which are not scientifically verifiable ([Dalla Barba, 2009](#)). However this model has been criticised for being based on observations rather than on rigorous scientific data ([Schnider, 2003](#)).

Nevertheless, Dalla Barba's Confabulation Interview is the only established protocol for exploring confabulations across episodic, semantic, personal, non-personal domains ([Dalla Barba, 1993a](#)). This protocol was used in the present study in order to elicit confabulations.

1.3.1.2. Temporal context confusion

The distorted temporality characteristic of confabulators is the focus of one of the most influential models to date: the Temporal Context Confusion Model (TCC) ([Ptak and Schnider, 1999](#)). Schnider believed confabulators often had a distorted sense of time independent of memory deficits ([Schnider, 2008, p230](#)). His model refers specifically to 'behaviourally spontaneous confabulations' ([Schnider, 2008](#)). These are false memories that occur in the absence of an external trigger and that direct behaviour. This model influenced the present investigations into potential predictors of a) the appearance, and b) the clinical course of confabulation. Therefore it is reviewed in detail next.

1.3.1.3. Clinical evidence for temporal context confusion

Schnider's model was developed from a series of elegant experiments employing a temporal context confusion task (TCC). A small group of behaviourally spontaneous confabulators failed this TCC task. The TCC task is described in detail in chapter 2 of this thesis, but essentially it consists of two runs of a continuous recognition task (run 1 and run 2). The first run measures straight forward storage and recognition. In the second run, however, items that in the previous run were targets become distracters and vice versa. As a result the targets in the second run suffer intense interference from former targets, and consequently this part of the task cannot be completed relying on familiarity alone.

In a series of investigations behaviourally spontaneous confabulators performed as well as amnesic controls in the first run of the TCC task, whereas they consistently failed the second part. Schnider & Ptak ([Schnider and Ptak, 1999](#)) initially concluded from these results that spontaneous confabulators were unable to suppress memories that were currently incorrect. However this explanation did not accommodate processes such as day-dreaming or creativity. Therefore this deficit was later reformulated as an inability to 'filter' incoming information that pertains to ongoing reality ([Schnider, 2008, pp. 267-272](#)).

Schnider followed up 8 confabulators who performed the TCC task again after 3 years ([Schnider et al., 2000a](#)). All the patients who had stopped confabulating performed normally on the TCC task. No other cognitive measures paralleled the course of confabulation. Therefore Schnider concluded TCC was necessary and sufficient to explain the presence and clinical course of confabulation ([Schnider et al., 2000a](#)).

Based on this model, Schnider made some treatment suggestions. He discouraged challenging confabulations directly. Confabulators are so convinced of the false statements' veracity that their denial often leads to anger and anxiety ([Schnider, 2003](#)). No controlled trials exist, but Schnider has had some success with dopamine antagonists risperidone and quetiapine, depending on the patient. He recommends trying short doses of neuroleptics in the first instance ([Schnider, 2008, p.251](#)).

Over time significant limitations of the TCC task have been described. Schnider himself described a confirmed confabulator who performed normally on the TCC task. This was attributed to the patient having adopted a conservative response criterion as a strategy in order to cope with the confusion caused by the TCC task (Schnider, 2008, p.251). Another patient did not confabulate despite abnormal TCC performance. Schnider suggested that perhaps this person's preserved memory function had overridden the effects of TCC, thereby stopping confabulation (Schnider, 2008, p.251). Gilboa et al. (2006) also found that a group of patients who had suffered anterior communicating artery aneurysm (ACoA) did poorly on this task, despite being free from confabulations. This indicates that although TCC may be sensitive to confabulation, it is not specific to the syndrome. Instead, TCC may be specific to pathology that affects the ventromedial prefrontal cortex (VMFC) (Gilboa, 2010).

Despite criticism, Schnider's results with this task have been replicated either totally or partially (Schnider and Ptak, 1999; Schnider et al., 2000a; Turner et al., 2010; Gilboa et al., 2006). Therefore this task was used in the present study to explore the value of TCC in predicting a) the appearance and b) recovery from confabulation.

1.3.1.4. Imaging evidence for temporality models

Further reformulation of Schnider's model came from neuroimaging studies. Schnider et al. (2000b) scanned a healthy sample while carrying out a more difficult version of the TCC task. Results showed brain activation during the

critical part of the task (run 2) corresponded to the posterior medial orbitofrontal cortex (BA13).

Evoked potentials and cortical activation maps showed a striking difference in frontal brain activation between distracters in run 2 and other stimuli. At 200-300 milliseconds after stimuli presentation, processing of distracters in run 2 skipped a stage of cortical synchronisation. This early activity occurred even before encoding took place (at 400-600 ms) ([Schnider et al., 2002](#)).

One explanation put forward was that activated memories go through a preconscious 'filtering' stage. If memories are not currently relevant, the orbitofrontal cortex (OFC) inhibits cortical synchronisation. In this way memories are tagged as either being currently relevant or not, and go on to influence behaviour accordingly ([Schnider, 2003, 2008, p.269](#)).

Why should confabulators be so convinced of their false memories even in the face of contradictory evidence? Schnider speculated that confabulations represent a behavioural extinction deficit. He noted that primates with ablations of the OFC had trouble extinguishing responses that are no longer required. Therefore he proposed that perhaps confabulators had difficulty extinguishing memories that are no longer relevant to their current situation.

PET experiments in which healthy participants performed decision-making tasks showed that extinction trials underwent different processing to other trials at 200-300ms. The areas involved were BA10 and BA13. One explanation was that the OFC acted as an "outcome monitoring system" signalling the non-

occurrence of a predicted event through cortical activation. Absence of this signal would lead to a false sense that predictions had been met. In the case of confabulators, it would provide certainty that the event recalled was correct (Schnider, 2008, p.291).

1.3.1.5. Summary of temporality models

In summary, temporal models focus on a strikingly distorted sense of time which is characteristic of confabulations. Clinical experiments suggested temporal context confusion (TCC) was the critical disorder that predicted both the appearance and recovery from confabulation. Imaging experiments suggested the OFC was responsible for early inhibition of cortical synchronisation of memories that are not currently relevant. Schnider proposed that confabulations appear when this early 'filtering' or 'extinction' process is faulty.

Schnider's TCC task has been used in the present study in order to examine his claims that TCC predicts both the appearance and the clinical course of confabulation.

Aspects of this model do not seem incompatible with some features of strategic retrieval models, which are reviewed next. The basic deficit in confabulation proposed by Schnider is one of faulty monitoring during memory reconstruction (Schnider, 2008, p.270). Indeed Schnider's 'filtering' mechanism is not dissimilar to other filtering processes reviewed below ((Gilboa, 2010); compare Burgess' notion of 'gateway' sited in BA10 (Burgess et al., 2007a, 2007c). In addition the OFC as an "outcome monitoring system" is not dissimilar to the

idea that the OFC is involved in “matching events to internal predictions” (Turner et al., 2008b). However despite some commonalities, specific hypotheses arising from either model may lead to opposing predictions.

1.3.2. Strategic Retrieval Models

Early authors (e.g. Korsakoff, Kraepelin and Tiling) explained confabulations as a combination of amnesia deficits and a monitoring deficit (DeLuca, 2009; Schnider 2008). Kapur and Benson had highlighted the role of executive dysfunction on confabulation (Kapur and Coughlan, 1980; Benson et al., 1996). The following explanations of confabulation hinge on the dysfunction of specific control mechanisms that operate during normal recollection.

1.3.2.1. Memory reconstruction processes

Several authors see memory as a series of constructive processes, and as such, open to errors during memory reconstruction (Schacter et al., 1998; Moscovitch and Melo, 1997). Cognitive mechanisms proposed by these models apply both to normal and abnormal memory. Two key processes of successful memory retrieval have been proposed:

1. different elements of the information to be retrieved must be ‘bound’ together in order to produce a coherent memory. Dysfunction of this process leads to source memory deficits, where events are recollected without important details, e.g. timing or location in which the event occurred.

2. similar events must be distinguished from the specific memory to be retrieved. If this didn't happen, only the 'gist' of an event would be remembered.

Control mechanisms underlying memory reconstruction

Confabulation (of any type) arises as a consequence of dysfunction of one or more executive processes involved in memory reconstruction (Moscovitch and Winocur, 2002; Burgess and Shallice, 1996; Kopelman, 1999). These can be related either to the search strategy or to the monitoring of the retrieved information (Moscovitch and Melo, 1997). Three main strategic retrieval processes are described: 'descriptor', 'editing', and 'mediating' processes (Burgess and Shallice, 1996; Burgess and McNeil, 1999; Gilboa and Moscovitch, 2002).

1. 'Descriptor' or cue specification processes are responsible for generating internal cues to guide information retrieval. Normally 'generic memories' are used as default "starting value templates" to speed up the process of memory reconstruction (Burgess and Shallice, 1996; Moscovitch and Winocur, 2002). They are subsequently refined and modified as they undergo verification (Moscovitch and Melo, 1997). However, in the absence of adequate specifications to guide recollection, these generic "input templates" are erroneously reported as the target memory (Burgess and Shallice, 1996). The absence of descriptor cues could also result in exaggerated 'cueing' effects in recollection; this would be the case, for example, of a patient who mistakenly reported she was a

member of staff in the hospital in which she was a patient ([Kopelman et al., 1997](#)).

2. 'Editing' or monitoring mechanisms are responsible for verification, accuracy checking and comparison of retrieved memories ([Burgess and Shallice, 1996](#); [Moscovitch and Winocur, 2002](#)). Malfunction of these verification processes would mean that retrieval of erroneous material would go unchecked.
3. 'Mediator' processes are problem-solving processes, not necessarily specific to memory. If retrieval of a false memory is detected, mediating processes would prevent its erroneous output and redirect the search. Fantastic confabulations are caused by malfunction of 'mediator' processes which fail to check the general plausibility of the material remembered.

One criticism of the above model is that the monitoring processes proposed are not specific to confabulation – they apply to true memories too; furthermore, they do not distinguish between different types of confabulation ([Schnider, 2008, pp.227-228](#)). Further critique argues that these models rely on non-observable processes that make verification of these theories difficult ([Dalla Barba, 2009](#)). For example there is lack of evidence of the physiological basis of the monitoring processes described by these models ([Schnider, 2008](#), p.228). Some of the models have been developed without reference to clinical data ([Schnider, 2001](#)). Finally, they do not explain the confusion that usually accompanies confabulation ([Schnider, 2003](#)).

1.3.2.2. Cognitive mechanisms underlying confabulation

A recent model has structured the above processes in a different way and extended the above model. Gilboa and colleagues ([Moscovitch and Melo, 1997](#); [Gilboa, 2010](#)) proposed that three types of cognitive mechanisms underlie confabulation: 1. 'core' processes, which are essential for the appearance and course of confabulations, and are specific to this syndrome; 2. 'constitutional' processes, which may be necessary but are not specific to confabulations; and 3. 'associated' features, which are not critical for the appearance of confabulations, but may influence their content. Three types of 'core' processes are reviewed below, followed by a summary of 'constitutional' processes and 'associated' features, as proposed by Gilboa and colleagues.

'Core processes'

Three 'core' mechanisms are described; the first two are different types of monitoring processes: (i) a "Preconscious Feeling of Rightness (FOR)"; (ii) Conscious Monitoring mechanisms; and (iii) Control processes.

(i) "Preconscious Feeling of Rightness (FOR)" mechanisms appear to be heuristic decision-making processes that verify retrieved memory traces and tag them accordingly, very early in the process of retrieval. When these processes break down, false memories may be accepted as correct. In addition false memories that are autobiographical in nature may direct behaviour, because they are held with great conviction. This may be because autobiographical information is both very well established and salient to each individual.

(ii) Conscious Monitoring mechanisms are more thorough verification processes, which take place later in the process of retrieval (Gilboa, 2010; Burgess and Shallice, 1996). Memories are verified against retrieval cues, and contrasted with available information. If these mechanisms function correctly they may overhaul FOR processes and prevent confabulations. Breakdown of conscious monitoring mechanisms may result in fantastic or inconsistent confabulations.

(iii) Control processes allow us to consider the consequences of reporting the retrieved material, and help us decide whether to report it or not. For example if the cost of reporting a memory is too great should it turn out to be false, the person may decide to withhold it. Even if the other two core mechanisms are faulty, Control processes may stop a confabulation from being reported. For this reason all three core mechanisms must be faulty in order for confabulations to appear.

Constitutional processes

Constitutional processes are described as those that are usually associated with confabulation, but are *not unique* to confabulation. Deficits in these processes may be necessary for the appearance of confabulation, but they are *not sufficient*. For example a memory deficit seems to always accompany confabulation but it is not specific to this syndrome. Search initiation and cue specification deficits may also contribute to the appearance of confabulation, but can also appear in its absence. In contrast with Schnider (2008), these

authors claim that temporal context confusion (TCC) may be sensitive but not specific to the presence of confabulation. Failure in this task has been associated with particular brain pathology in the ventro-medial prefrontal cortex, rather than with confabulation per se ([Gilboa et al., 2006](#)).

From the above reviews it seems that although temporality and strategic retrieval models share common features, some specific hypotheses may lead to opposing predictions for the current data. Thus if, on the one hand, TCC is specific to confabulation, then only confabulating patients should fail the TCC task. If on the other hand, TCC is not specific to confabulation, then it is expected that failure on this task will be observed in non-confabulating controls too. Both explanations are discussed in relation to present investigations into the predictors of the presence and clinical course of confabulation. These questions are addressed in the cross-sectional and longitudinal investigations reported in chapters 3 and 4 of this thesis respectively.

Associated features

Associated features may be present in connection with confabulations but are often absent, therefore they are not considered constitutional to the syndrome. They typically determine the content of confabulation and form part of normal reconstructive function. For example many confabulations have a self-serving bias (see [Fotopoulou, 2010](#) for a review), but this may not be a universal bias ([Metcalf et al., 2010](#)). Confabulations often represent 'generic' well rehearsed memories ([Burgess and McNeil, 1999](#); [Dab et al., 1999](#); [Metcalf et al., 2010](#)). These seem to be exacerbations of normal recollection errors and appear in

many contexts. Perseveration has also been observed in confabulators, especially in semantic memory ([Kopelman et al., 1997](#)), but this seems to be associated with frontal pathology in general. Associated features are discussed in relation to the current investigation into the affective content of confabulations in chapter 5 of this thesis.

1.3.2.3. Imaging evidence in support of strategic retrieval models

Strategic retrieval models are based on imaging and behavioural experimental data in support of both monitoring mechanisms and Control processes. Imaging data showed patients with ventromedial prefrontal cortex (VMFC) lesions skipped an early positive modulation that was present in controls at 240ms post-stimulus ([Gilboa, 2010](#)). This appears to be consistent with Schnider's imaging data reviewed above that showed an early deactivation ([Schnider et al., 2002](#)). Furthermore, Gilboa's patients also lacked a positive modulation that controls showed at a later stage: 350ms post-stimulus. Gilboa ([2010](#)) argued that these two results would support the theory that two distinct monitoring mechanisms are critical for the appearance of confabulation: i) early "Feeling of Rightness" (FOR) and ii) late and more in-depth monitoring processes.

1.3.2.4. Clinical evidence in support of strategic retrieval models

Behavioural experiments showed that confabulators seem to report false memories even when the need for cue specification and creating a search strategy are minimised ([Gilboa et al., 2006](#)). One confabulating patient made far more errors than controls, despite showing a general conservative response

criterion on a free report memory task (she only reported information if she was at least 75% sure it was true, [\(Gilboa, 2010\)](#)). These results indicate that confabulation is not merely the consequence of a general bias or a response inhibition deficit, but a very specific monitoring deficit (compare [Turner et al., 2008a](#)). Confabulations were also associated with an indiscriminate sense of confidence in their veracity, even when they were highly implausible ([Gilboa et al., 2006](#)). These findings are consistent with a specific deficit in “Preconscious Feeling of Rightness” (FOR) as a critical mechanism in the appearance of confabulation.

Evidence for the role of Control processes in confabulation comes from a single case experiment where the confabulating participant was free to withhold answers during the course of free report (rather than structured interview, [\(Gilboa, 2010\)](#)). This patient seemed unable to stop generating answers, even after she had reported the correct answer. This is consistent with the critical role of Control mechanisms in the appearance of confabulations.

Furthermore, using tasks sensitive to confabulation, Gilboa ([2010](#)) found delusional patients presented a distinct pattern of response to that of confabulators. In contrast with confabulators, delusional patients showed poor control function, good monitoring ability and a liberal response bias. They further differed from confabulators in that they did not show a primary memory deficit.

1.3.2.5. Summary of strategic retrieval models

In summary, strategic retrieval models explain confabulation as a dysfunction of monitoring mechanisms that operate during normal memory reconstruction. They do not discriminate between different types of confabulation. 'Core' cognitive processes that are critical and specific to the appearance of confabulations include: (i) an early 'Feeling of Rightness' about a memory; (ii) a more in-depth Monitoring process; and (iii) Control mechanisms that allow the individual to decide whether to report a memory or not, irrespective of its perceived veracity. All three must be impaired for confabulations to appear. 'Constitutional' processes may be necessary, but they are neither specific to nor sufficient for the appearance of confabulations. Memory deficits and temporal context confusion fall into this category. 'Associated' features have been observed during confabulation, but they are often absent. These may affect the content of confabulation, for example making it predominantly self-serving, or generic (i.e. devoid of detail).

Strategic retrieval models provide the most comprehensive explanation of confabulations. Consequently they are discussed in relation to the main questions of the present study in the following chapters. They share a common base with motivational models. Both types of models explain confabulations as distortions of normal memory reconstructive mechanisms. However, motivational models make specific predictions about the *content* of confabulations. They are reviewed in the next section.

1.3.3. Motivational models

Explanations based purely on cognitive deficits such as memory, monitoring, etc. neglect answering the question of why a particular memory happens to be selected for output over any others ([Fotopoulou, 2009](#)). Yet existing evidence indicates the content of confabulations is not simply random, a good proportion of the themes can be traced back to particular preoccupations or autobiographical events of the individual ([Burgess and McNeil, 1999](#); [Schnider, 2008](#)), so how do some themes get selected over others? Previous theoretical models have addressed the mechanics of the appearance and course of confabulation; motivational explanations address specifically the question of what determines the content of confabulation.

Precursors of motivational explanations have proposed several determinants of the content of confabulation. Williams and Rupp (1938, cited in [Schnider, 2008](#)) introduced personality traits in the definition of confabulation. They proposed confabulation was a function of several factors: memory deficit, lack of insight and a particular personality pattern, which included a tendency towards introversion ([Schnider, 2008](#)).

Flament (1957, cited in [Schnider, 2008](#)) explained confabulations in function of unconscious 'compensation' mechanisms: either to compensate for memory deficits or to provide a more rewarding situation than the reality they experienced as a consequence of the trauma ([Schnider, 2008](#)).

Talland (1965) considered confabulations as secondary to amnesic deficits. He proposed that personal dispositions or characteristics determined the presence, rate and quality of confabs. He observed that some confabulations presented the past in a more positive light than the present.

Recent motivational accounts of confabulations, like most theoretical models, explain confabulations in function of faulty memory and control mechanisms. In addition to this, and more importantly, they propose confabulations are driven by personal goals or self-images. The authors argue these same motivational influences moderate memory formation in healthy individuals; however in confabulations these tendencies have an exaggerated influence on recollection, due to breakdown of memory and executive functioning (Fotopoulou and Conway, 2004; Conway and Pleydell-Pearce, 2000; Fotopoulou, 2009; Metcalf et al., 2010).

1.3.3.1. The Self-Memory System (SMS)

Memory processes may not operate in isolation; instead memory and control processes may interact with identity formation processes. The resulting interacting network is referred to as the “self-memory system (SMS)” (Conway, 1997; Conway and Pleydell-Pearce, 2000). Autobiographical memories are viewed as transitory mental constructions generated from an underlying knowledge base. Constant patterns of activation would arise over the knowledge database we hold; these would be monitored and inhibited by control processes as required. Control processes would be modulated by active goals generated by the working self. The two components of the SMS: the

autobiographical knowledge base and the working self, are briefly described below. This is followed by an account of how damage to these components can result in confabulations.

The Autobiographical memory store

The autobiographical knowledge database is said to be organised around lifetime periods (i.e.: “when I lived with X”, etc), general events (i.e.: repeated events or routines, e.g.: how to ride a bicycle), and event-specific knowledge (Conway, 1997; Conway and Pleydell-Pearce, 2000). Knowledge stored as lifetime periods provides cues that can be used to recall a given set of general events, and knowledge stored as general events indexes event-specific knowledge. A specific autobiographical memory is described as a stable pattern of activation over these knowledge structures. The construction of autobiographical memories is said to be constrained by strategic retrieval and monitoring control processes, and these in turn are modulated by goals generated by the working self; this is reviewed below (Conway and Pleydell-Pearce, 2000).

The Working Self

The working self is described as a collection of self-schemas, or representations of the self, that modulate cognition and behaviour (Conway and Pleydell-Pearce, 2000; Conway, 2005). The self-image is constantly being updated; a number of possible representations of the self are either adopted or rejected at any given time.

Tensions or discrepancies between different self-representations ('actual self', 'ideal self', 'ought-to-be self') cause emotional distress. Consequently a set of goals and plans are generated to reduce distress by increasing coherence between self-concepts. Thus, achievement of 'self-goals' is associated with positive emotion. In this way the goals of the working self are described as a subset of working memory control processes that bias memory retrieval; for example, they may increase accessibility of memories which support important goals and self-images; memories that contradict them may be assigned low accessibility ([Conway, 2005](#)).

The 'self-goals' and highly changeable self-representations are constrained by long-standing autobiographical memories; these lend stability and plausibility to self-concepts and goals ([Conway and Tacchi, 1996](#); [Conway and Pleydell-Pearce, 2000](#)). Therefore, the role of the working self may be two-fold: (i) to 'ground' goals in reality by basing them on accurate memories, and (ii) simultaneously making available knowledge and memories that support current self-concepts and show some positive progress towards current goals. In other words the working self fulfils the need for coherence both with external reality and with internal personal images and wishes ([Conway, 2005](#)).

Inconsistency between self-goals and knowledge base would indicate a breakdown in normal functioning. If the reciprocal constraints between autobiographical knowledge and working self are removed, potentially, autobiographical knowledge could be constructed to support goals and plans without reference to reality. This could lead to confabulation and other

neurological pathologies ([Conway and Pleydell-Pearce, 2000](#); [Conway, 1997](#)).

Clinical evidence for this model of confabulation is briefly reviewed below.

1.3.3.2. Evidence of self-referent content in confabulations

Most authors acknowledge the prominence of personal content in confabulations ([Dalla Barba and Boisse, 2010](#); [Metcalf et al., 2010](#); [Gilboa et al., 2006](#); [Kopelman, 1999](#)). Memory and dysexecutive deficits can distort both the search and evaluation of autobiographical memories in such way that personal goals may have an exaggerated influence on memory reconstruction ([Metcalf et al., 2010](#); [Burgess and McNeil, 1999](#); [Gilboa et al., 2006](#)). The resulting memories then would show disproportionate self-referent and possibly self-enhancing biases ([Fotopoulou, 2009](#)). The strong and selective influence of personal schema on recall was illustrated by a prose recall experiment ([Fotopoulou et al., 2008a](#)). In this investigation confabulating patients showed a selective bias when they recalled self-referent prose. This bias was absent from their recall of non-self-referent information. This discovery has potential implications for treatment; for example, information expressed in the 3rd person may be recalled more accurately by patients than information in the 1st person ([Fotopoulou et al., 2008a](#); [Fotopoulou, 2009](#)).

1.3.3.3. Evidence of self-coherence in the content of confabulations

Furthermore most confabulations reported in the literature appear to refer to frequently repeated habits or 'generic' personal memories ([Dalla Barba and Boisse, 2010](#); [Metcalf et al., 2010](#); [Burgess and McNeil, 1999](#)). For example

Burgess and McNeil (1999) reported a confabulating patient, a former shop-owner, who kept trying to leave hospital in order to carry out a stock count. The authors argued this activity would have featured predominantly in his life prior to admission to hospital; retrieval of these highly rehearsed memories is likely to be automatic and would have gone unmonitored due to executive dysfunction (Burgess and McNeil, 1999; Metcalf et al., 2010; Gilboa et al., 2006). In addition to poor monitoring, confabulating patients present with severe disruption of autobiographical memory function. As a consequence of these deficits they may not be able to select the appropriate life-time period to guide recollection. In this context they may misinterpret past memories or current cues according to the goals and expectations of a particular life-time period (Fotopoulou and Conway, 2004). In addition, patients have been observed to minimize the deficits caused by their neurological condition and explain them as premorbid features. This could indicate an exaggerated bias to maintain an account of themselves that is coherent with their past self-image (Fotopoulou, 2009).

1.3.3.4. Evidence for self-enhancement in the content of confabulations

Confabulating patients report more pleasant confabulations than non-confabulating controls, as rated by independent judges (Fotopoulou et al., 2004, 2008b). Typically they have been observed to inflate their abilities in the face of their current deficits, or to embellish their past (Fotopoulou et al., 2007a). For example a confabulating patient may replace past disappointing family interactions in his/her life with more pleasant confabulated memories about successful close relationships (Conway and Tacchi, 1996). Further evidence of the self-enhancing nature of confabulations comes from an experiment where

the emotional nature of the information to be remembered was manipulated (Fotopoulou et al., 2007b). Confabulating patients were given incorrect information about themselves. They were more likely to adopt the false autobiographical memories as true when these were positive than when they were negative (Fotopoulou et al., 2007b). Another experiment showed that confabulating patients' recall of negative self-referent information was distorted in a way that showed them in a better light (Fotopoulou et al., 2008a).

Biases towards pleasant content have been widely observed in confabulations; however, they are not universal (Gilboa, 2010; Metcalf et al., 2010; Fotopoulou, 2010). Therefore the emotional content of confabulations is unlikely to be caused by generalised affective dysregulation. In addition, confabulations with a somewhat unpleasant theme, such as being in a prison, or at a relative's funeral, have been consistently reported (Schnider, 2008; Metcalf et al., 2010). Their negative emotional valence may reflect islands of awareness of deficits or unpleasant past events. Related to this, patients often dramatise the circumstances of their condition (Fotopoulou et al., 2008b). This can be interpreted as a form of 'idealising' their identity (Fotopoulou, 2009). Thus even emotionally negative confabulations may have a self-serving purpose (Fotopoulou, 2010).

It has been argued that the self-enhancing nature of confabulations has a specific function: it may act as an adaptive 'defence' mechanism that preserves patients' well-being and sense of self against a changing and often 'dire' personal situation (Fotopoulou, 2009). The pleasantness of confabulations was found to be associated to severity of depressed mood. In other words, the

higher the score on the depressed mood scale, the more pleasant was the content of the patient's confabulations (Fotopoulou et al., 2008b). Elsewhere elderly patients have shown the same self-enhancing biases in autobiographical recollection. Since both older adults and confabulating patients suffer memory and executive functioning decline, it is argued that the exaggerated self-coherence and self-enhancement tendencies in these populations result from deficits in executive memory processes, and related failure to adequately control the influence of the working self on autobiographical memory (Fotopoulou, 2009, 2010).

1.3.3.5. Summary of motivational models

In summary, motivational accounts propose that the content of confabulations is modulated by healthy autobiographical memory and identity formation processes. Healthy autobiographical memories typically satisfy two constraints: 1. they are consistent with personal plans, goals, and self-images, and 2. they correspond to past experiences and ongoing reality. Biases observed in the content of confabulations may represent difficulties managing the two constraints due to severe memory and monitoring deficits. Resulting memories may be coherent with current or past self-concepts, which may or may not correspond to ongoing reality. Confabulations may have a self-serving bias and may be disproportionately positive. This bias may protect an individual's integrity and well-being in the context of extremely changing and threatening conditions.

Motivational theorists have used independent ratings on the content of true and false memories in order to make specific predictions about emotional biases of confabulations. The same methodology has been employed in the present investigation. This and implications of results from the present investigation into emotional biases in the content of confabulations are discussed in chapter 5 of this thesis.

Finally, having reviewed the main theories, in the next section key aspects of the above models and relevant evidence are drawn together to inform the questions investigated in the present programme of studies.

1.4. STUDY RATIONALE

Temporal Context Confusion (TCC) has been put forward as the only critical feature that predicts both the appearance of and recovery from confabulations ([Schnider 2008](#); [Schnider et al., 2000a](#)). This claim has been countered with evidence that indicates TCC may be sensitive to the presence of confabulation, but it is not specific to this disorder. For example in one study performance on the TCC task did not differ between confabulating and non-confabulating participants who had suffered anterior communicating artery aneurysm ([Gilboa et al., 2006](#)). In summary existing literature shows that there is conflicting evidence regarding which cognitive mechanisms predict the presence and clinical course of confabulation. Therefore one of the aims of the present study was to establish whether TCC predicted both the appearance and clinical course of confabulation better than any other potential predictors.

In addition to cognitive deficits, several authors have observed that confabulating individuals lacked insight into their condition ([Weinstein and Kahn, 1950](#); [Schnider, 2008](#)). Lack of insight is also considered an integral characteristic of the syndrome of confabulation in some of the theoretical models reviewed above (e.g. [Burgess and Shallice, 1996](#)). Furthermore evidence suggests that recovery from confabulation may be accompanied by increased awareness of amnesia and confabulation ([Feinberg and Roane, 1997](#); [Mercer et al., 1977](#)). However insight has not been measured formally in previous studies. Therefore, another aim of the present study was to examine the relative predictive value of level of insight in the appearance and clinical course of confabulations.

Furthermore, it is clear from the above review that most authors acknowledge confabulations are modulated by mood and/or emotional factors. Pleasant confabulations may be associated with severity of depressed mood; they may play a 'protective' function against suffering a catastrophic reaction ([Fotopoulou et al., 2008b](#)). On the other hand, hypomania has been observed to be present alongside confabulation in several cases described in the literature ([Schnider, 2008](#)). Moreover hypomania has been found to increase the number of false positives reported in a recognition memory task similar to the TCC task. Furthermore, when this mood disorder was treated with beta-blockers, the number of false positives decreased ([Corwin et al., 1990](#)). Taken together these findings suggest that depressed and/or elated mood may modulate the appearance and clinical course of confabulations. However, mood has rarely been measured formally in previous studies. Therefore another aim of this study

was to examine the relative predictive value of depressed and elated mood in the appearance and clinical course of confabulations.

Related to this there appears to be some controversy regarding the nature of the affective biases in the content of confabulations. The majority of confabulations reported are pleasant. However, this bias may not be universal (Fotopoulou, 2010; Metcalf et al., 2010). For example, confabulations with unpleasant content have been frequently observed (Schnider, 2008). Recent studies have shown that the majority of confabulations reported are in fact emotionally neutral (Metcalf et al., 2010; Dalla Barba and Boisse, 2010). Moreover, most investigations into emotional biases of confabulations have been carried out with single cases or small samples. Therefore another aim of this study was to examine the affective bias of the content of confabulations in a large sample.

In summary, the aims of the present programme of studies were threefold:

1. to investigate the relative contribution of TCC, mood and insight in predicting the *presence* of confabulation (study 1 in chapter 3);
2. to investigate the relative contribution of TCC, mood and insight in predicting the *clinical course* of confabulation (study 2 in chapter 4); and
3. to examine the affective bias in the content of confabulations, and the relation of this affective bias to current mood state (study 3 in chapter 5).

The following chapters describe three studies carried out in order to address each of the above aims and the methodology used. Resulting findings are

discussed in relation to the theoretical models reviewed above and any other relevant evidence.

Chapter 2

Method

2.1. DESIGN

The present study had the following 3 aims:

1. to investigate the relative contribution of TCC, mood and insight in predicting the *presence* of confabulation;
2. to explore the relative contribution of TCC, mood and insight in predicting the *clinical course* of confabulation; and
3. to examine the affective bias in the content of confabulations, and the relation of this affective bias to current mood state.

Three studies were carried out in order to achieve these 3 aims. The design for each study is presented below. This is followed by sample power calculations.

2.1.1. Study 1 – Cross-sectional investigations

In this study the relative contribution of TCC, mood and insight in predicting¹ the *presence* of confabulation was explored. First, in order to establish which of these measures discriminated between confabulating and non-confabulating patients 2 groups of brain injured amnesic individuals: those with and without

¹ Please note: throughout study 1 – cross-sectional investigations: the term ‘predictor’ is used in its statistical sense, usually in order to refer to concurrent associates.

confabulations, were compared in terms of mood, TCC, awareness of difficulties and background cognitive measures. Both brain injured groups were also compared to a healthy control group on the TCC and mood measures to determine whether the scores of the patients on these measures were in the normal range. Second, the concurrent association between TCC, mood, insight and the presence of confabulation was examined. Third, the sensitivity and specificity of the best model of predictors (or concurrent associates) of the presence of confabulation were examined.

2.1.2. Study 2 – Longitudinal investigations

In this study the relative contribution of TCC, mood and insight in predicting the *clinical course* of confabulation was explored. A group of confabulating brain injured participants were followed over approximately 9 months. Participants were assessed within a month of being referred to the study, then 3 months later, and again 6 months later. First, changes in confabulation, TCC and background cognitive measures were examined. Second, the relative contribution of initial levels of TCC, mood and insight in predicting change in confabulation was examined.

2.1.3. Study 3 – Affective valence of confabulations

This study investigated whether confabulations had affective content, and whether this affective content (or valence) was associated with mood state. The content of confabulations produced by the experimental group was rated by independent judges and examined in relation to a) the 'real' facts that

confabulations had replaced and b) true memories reported by participants. These emotional ratings were correlated with self-rated mood state. Finally, differences in the pattern of affective content between those participants who had focal pathology in the ventromedial or orbitofrontal cortex and those who did not were examined.

2.1.4. Sample power calculations

The present power calculations were derived in order to ascertain the number of participants needed in order to detect a significant difference in performance on the TCC task between confabulating and non-confabulating brain injured amnesic participants.

Table 2.1 shows the two power calculations carried out for this programme of studies. An initial calculation (based on previous TCC means from confabulating and non-confabulating participants ([Schnider et al., 1996](#)) indicated that a sample with 6 patients in each group would provide a power of 0.80 at an alpha of 0.015 (2-tailed). However, scientific rigour indicated that out of 6, at least 2 were likely to be outliers, thus potentially spoiling the results. Therefore, following the advice of the statisticians consulted, it was initially proposed to use 12 confabulating and 12 non-confabulating brain injured patients in the present studies.

Table 2.1. Power calculations. Calculation 1 was based on data from previous studies. Calculation 2 was based on combined data from: a) a preliminary experimental sample from the current study, and b) control data from a previous study.

	<i>Calculation 1</i>	<i>Calculation 2</i>
Alpha (2-sided)	0.015	0.001
Power	0.80	0.97
Mean1 (SD1)	0.67 (0.38)	0.63 (0.40)
Mean2 (SD2)	0.13 (0.09)	0.13 (0.09)
Sample size per group	N1 = 6 N2 = 6	N1 = 24 N2 = 12
Original sample sizes	N1= 5 confabulators N2= 9 amnesics	N1 = 10 confabulators N2= 9 amnesics
Source	(Schnider et al., 1996)	N1 : Current study N2 : (Schnider et al., 1996)
Software	NQuery 4.0	http://calculators.stat.ucla.edu/powercalc (accessed 28.06.2006)

A second calculation was carried out with a combination of preliminary data from 10 confabulating patients recruited for the present study and controls' means from the above mentioned study ([Schnider et al., 1996](#)). This calculation indicated that a sample with 24 patients in the experimental group and 12 in the control group would provide a power of 0.97 at an alpha of 0.001 (2-tailed).

2.2. PARTICIPANTS

2.2.1. Inclusion criteria

For all patients: In order to be included in the study patients had to have a primary diagnosis of single incident, non-congenital, non-progressive brain

injury of any type. Participants were recruited as early as possible post-diagnosis.

For confabulating patients: patients were recruited to this group if they showed evidence of substantial confabulatory behaviour, indicated by having to meet all 3 of the following criteria:

1. evidence of observable confabulatory behaviour as recorded in their medical notes, plus
2. evidence of observable non-trivial confabulation during initial interview with investigator, plus
3. patient gave 8 or more confabulatory answers to the Episodic Memory subtest of the Dalla Barba's Confabulation Battery ([Dalla Barba, 1993a](#)).

For non-confabulating patients:

1. no evidence of confabulatory behaviour observed by the clinical team at the time of referral to the study;
2. absence of confabulatory behaviour over and above that of the general population observed by the investigator on initial interview ([Burgess and Shallice, 1996](#));
3. patient gave less than 5 confabulatory answers to the Episodic Memory subtest of the Dalla Barba's (1993a) Confabulation Battery;
4. patient was matched as closely as possible to the experimental group on the following measures in order of priority:
 - a. delayed verbal and visual memory functioning (measured with WMS-III: Logical Memory 2 and Visual Reproduction 2) ([Schnider et al., 1996](#));

- b. the severity of cognitive impairment following their neurological deficits, indicated by their score on the Mini Mental State Examination (MMSE; [Folstein et al., 1975](#));
- c. age;
- d. time elapsed between diagnosis and referral to the study.

Following previous investigations ([Schnider et al., 1996](#)), the non-confabulating group was matched to the confabulating group primarily on memory.

For healthy participants: adults with no known psychopathology at the time of recruitment, were recruited to this group. They were matched to the experimental group on age and level of education ([Schnider et al., 1996](#)).

2.2.2. Exclusion criteria

Participants with primary diagnoses in ICD10 other than organic mental disorders were excluded. This was identified via inspection of medical notes.

Also excluded were patients who were in confusional states, as indicated by a score below 15 on the MMSE ([Folstein et al., 1975](#)).

People with severe cognitive, behavioural or language dysfunction that would prevent participation in the study were excluded. This was identified either via inspection of the medical notes, discussion with the clinical team or on interview.

In addition, the presence of confabulations for past autobiographic memories could only be verified with the help of an informant who knew the patient well. Therefore if no such person could be found the participant was excluded from the study.

2.2.3. Recruitment sites

Patients were recruited mainly from in-patient, but also from out-patient clinics of the following hospitals: Edgware Hospital Brain Injury Rehabilitation Unit (BIRU), South London and the Maudsley Trust (SLAM), Guy's and St Thomas' Trust hospitals, and Blackheath Brain Injury Rehabilitation Unit. In order to recruit healthy controls, relatives or carers of brain injured individuals were approached at BIRU's outpatient clinic.

2.2.4. Ascertainment

Confabulating patients: A total of 46 confabulating patients were approached. Three of these refused to participate in the study. Two patients started the study but did not complete the follow-ups. One patient was excluded because their severe confusion prevented meaningful conversation. Another patient was suffering a major mental health illness at the time of recruitment and was also excluded. Five patients were excluded because no informant was available to verify their confabulations. Another 10 patients were interviewed and excluded because they did not meet the criteria for evidence of confabulatory behaviour set above. This left 24 confabulating brain injured participants in the experimental group.

Non-confabulating patients: 23 non-confabulating brain injured controls were approached. Two of these refused to participate in this study. Another 2 did not complete the follow-ups. One patient was excluded because no informer was available to verify their memories. A further 7 patients were excluded because they did not meet the criteria for matching them to the experimental group set above. This left 11 non-confabulating brain injured patients in the control group; they were matched to confabulators for levels of amnesia.

Healthy participants: 6 healthy participants were approached and recruited.

2.2.5. Participant's demographic and injury characteristics

The final sample included 24 confabulating brain injured patients, 11 non-confabulating amnesic patients and 6 healthy participants. Demographic characteristics of the 3 groups are presented below.

Demographic variables

Differences between the 3 groups of participants on matching variables were examined. For this purpose chi-square and independent measures one-way ANOVA with group membership as the between subjects factor were used. Table 2.2 shows gender composition, age and level of education for the 3 groups. The healthy control group contained more female participants than the other 2 groups. The non-confabulating group was considerably younger than the other 2 groups, and this difference approached statistical significance.

Healthy controls had been in formal education for slightly longer than the other 2 groups. However none of these differences reached statistical significance.

Table 2.2. Demographic characteristics. *Mean (SD), range and significance of differences on gender composition, age and years of formal education between 3 groups: 24 brain injured confabulating patients, 11 brain injured amnesic non-confabulating patients and 6 healthy controls.*

	Group	N	Mean (SD)	Range	F/χ^2 (df)
gender % male	confabulating	24	83%	-	4.44(2)ns
	Non-confabulating	11	91%	-	
	healthy	6	50%	-	
age	confabulating	24	51.53(10.24)	32.2-70.1	3.10(2,38)‡
	Non-confabulating	11	41.87(13.27)	20.9-60.7	
	healthy	6	51.17(8.52)	44.0-63.0	
education	confabulating	24	12.12(2.80)	6-18	0.66(2,38)ns
	Non-confabulating	11	12.09(2.81)	8-18	
	healthy	6	13.50(2.17)	10-16	

ns=not significant; ‡p<0.07

Injury characteristics and background cognitive measures

Next confabulating and non-confabulating brain injured amnesic groups were characterised in terms of their diagnosis, and background cognitive measures used to match the 2 groups.

Table 2.3 shows the varied underlying pathologies that confabulating and non-confabulating patients had suffered. The majority of patients in both groups had sustained either hypoxic brain damage or traumatic brain injury. Hypoxia in most cases followed cardiac arrest (9/12); other causes of hypoxia included

epilepsy and acute renal failure. Traumatic brain injury in the current sample was caused primarily by road traffic accidents (6/12); other causes included falls and assault. In terms of premorbid history in the sample overall, 6 participants had a recorded history of substance abuse (primarily alcohol). All participants were free from active severe mental health illness at the time of recruitment. Clinical brain scans were available for 21 participants. They showed that 10 patients had suffered focal damage involving the ventro-medial frontal cortex (VMFC); 3 had sustained focal damage which did not extend to the VMFC; and 8 patients had suffered generalised atrophy.

Table 2.3. Diagnosis. *Diagnoses of 24 confabulating brain injured participants and 11 non-confabulating brain injured amnesic participants*

<i>Pathology</i>	<i>Confabulating patients</i>	<i>Non-confabulating patients</i>
Hypoxic brain damage	10 (42%)	2 (18%)
Traumatic brain injury	6 (25%)	6 (55%)
Subarachnoid haemorrhage	4 (17%)	1 (9%)
Wernicke-Korsakoff syndrome	2 (8%)	0 (0%)
Cerebral infection	1 (4%)	1 (9%)
Tumour	1 (4%)	1 (9%)

Length of post-traumatic amnesia (PTA) data was available for 10 confabulating and 10 non-confabulating participants. Table 2.4 shows that both groups had suffered severe brain damage ([Sohlberg and Mateer, 2001](#), p.34).

The mean interval between diagnosis of the neurological condition and recruitment to this study was shorter for the confabulating group than for the non-confabulating group; in other words confabulating participants were

recruited earlier than non-confabulating controls after their diagnosis. This difference just failed to reach statistical significance. For a comparison between the experimental and the control group on mood measures, please see chapter 3 in this thesis.

Table 2.4. Injury characteristics. *Length of post-traumatic amnesia and interval between diagnosis and recruitment to the study for 24 brain injured confabulating patients and 11 brain injured amnesic non-confabulating controls.*

	Group	N	Mean (SD)	Range	t(df)
PTA (days)	confabulating	10	30.4 (28.4)	0-90	1.13(18)ns
	Non-confabulating	10	48.3 (41.4)	0-140	
Post-injury interval (months)	confabulating	24	6.1 (3.7)	1.6-15.9	1.95(33)‡
	Non-confabulating	11	11.4 (11.6)	3.9-42.6	

ns=not significant; ‡p<0.07

Table 2.5 shows means, standard deviations, range, percentiles and t-test results of confabulating and non-confabulating patients on background cognitive measures used to match the 2 groups. No significant differences between the groups were found on any of these measures. MMSE scores showed both groups had sustained moderate to severe cognitive impairment, and their performance on the WMS-III showed their anterograde memory was very poor (below the 5th percentile). Of note, two WMS-III data points are missing. These participants' memory function was assessed initially with the Rivermead Behavioural Test, as it was deemed by their responsible clinicians they would not be able to perform meaningfully in the WMS-III. Their scores on the RBMT fell below the 'screening score', indicating similar impairment on memory function to the rest of the sample. In addition one person refused to complete

the delayed Visual Reproduction subtest. These scores have been omitted throughout this thesis.

Table 2.5. Matching variables. Means, standard deviations, range, percentiles and t-test results of brain injured amnesic confabulating and non-confabulating patients on background cognitive measures used to match the 2 groups.

Test	Group	N	Mean (SD)	Range	%le	t(df)
MMSE raw score	confabulating	24	20.1(3.8)	15-30	-	0.73(33)ns
	Non-confabulating	11	19.2(2.9)	15-23	-	
Delayed Logical Memory scaled score (WMS-III)	confabulating	22	2.4(2.1)	1-8	1 st	0.42(31)ns
	Non-confabulating	11	2.7(2.0)	1-7	1 st	
Delayed Visual Reproduction scaled score (WMS-III)	confabulating	21	4.1(1.6)	2-8	2 nd	0.08(30)ns
	Non-confabulating	11	4.0(1.5)	2-7	2 nd	

ns=not significant

2.3. MEASURES

In this investigation measures were used for 3 purposes: 1. experimental tasks were used in order to answer the study's questions; 2. screening measures were used to include participants in the study and to allocate them to either the experimental or the control groups; and 3. background cognitive tests were used to describe the clinical sample. These three types of measures are described below in turn. In addition, basic demographic and education data was collected via interview.

2.3.1. Experimental Measures chosen in order to answer the study's questions:

Dalla Barba Confabulation Battery ([Dalla Barba, 1993a](#))

Rationale & description: This semi-structured interview was selected because it elicits confabulation across a number of domains: personal semantic (e.g.: “why are you in hospital?”), personal episodic (e.g.: “what did you eat for dinner yesterday?”), orientation (e.g.: “what year are we?”), and general knowledge (e.g.: “when did World War I start?”). The interview also includes 2 sections with questions that most people are unable to answer (e.g.: “what was Marilyn Monroe’s father’s job”), to which some patients feel compelled to give confabulatory answers (they are known as the ‘don’t know’ sections for personal and non-personal information). Interview questions were updated from the original Italian to the current UK sample and are shown in Appendix 2.1 ([Kopelman et al., 1997](#)).

Scoring: Dalla Barba ([1993b](#)) scoring rules were used for the orientation section. No other instructions exist for other sections. Therefore the following system was used: answers were given a point if they contained false information as verified by the informant. Incorrect information that was presented as a guess was given half a point in order to capture confabulators’ exaggerated willingness to guess ([Mercer et al., 1977](#); [Kopelman et al., 1997](#)). Correct information did not attract any points.

Comments: This interview was used for several purposes: in study 1 number of confabulations within the episodic section was used as one of the criteria for allocating participants to groups. In study 2 both a) the number of confabulations produced across the whole interview, and b) number of confabulations within the episodic section were used as dependent variables, in order to investigate predictors of change in confabulation. In study 3 the content of participants' answers to the personal semantic and episodic sections were used in order to explore affective content in confabulations.

Temporal Context Confusion (TCC) task ([Schnider et al., 2000a](#))

Rationale: This task was used by Schnider, who found that TCC was the best predictor of the presence and clinical course of confabulation. Therefore it was used as an independent variable in studies 1 and 2 in order to examine the relative contribution of TCC to the prediction of the presence and clinical course of confabulation.

Description: This is an untimed continuous recognition task administered in two parts, 20 minutes apart from each other²: run 1 and run 2. Run 1 measures pure recognition ability for designs. Run 2 taps the ability to screen out well rehearsed, yet irrelevant material during recognition. The crucial difference between the two runs is that run 1 could arguably be completed relying on familiarity alone, whilst run 2 requires much more fine grained memory

² the original interval between runs was 60 minutes ([Schnider et al., 2000a](#)). However the authors obtained the same results with intervals as short as 5 minutes [Schnider and Ptak, 1999](#). In order to reduce the chances of participants becoming fatigued, we used a 20 minute interval, which is recommended in most standard memory tests

discrimination. The added difficulty in run 2 is borne out by the descriptions of the two runs below.

1. Run 1: 120 drawings of everyday objects and animals from [Snodgrass JG & Vanderwart M \(1980\)](#) were presented on a mackintosh laptop. Eight of the drawings were repeated 6 times (targets); the rest appeared only once (distracters). For each drawing presented participants indicated whether they had seen it already in this run or not. The experimenter then pressed the relevant computer key, and the next drawing appeared on screen immediately after.
2. Run 2: 20 minutes later, the same 120 stimuli were presented, but this time 8 of the stimuli which had been distracters in the previous run became targets and were repeated 6 times. At the same time the targets from run 1 became distracters in run 2. For each stimulus participants indicated whether they had seen precisely that same drawing already in this particular run, or not, irrespective of whether they had seen it in the previous run. The critical difficulty in this second run came from the intense interference from former targets. Schnider found that amnesic patients were able to overcome this interference, whilst confabulators could not. Thus this second run putatively dissociates between confabulating and non-confabulating amnesic participants ([Schnider et al., 1996](#)).

Scoring: TCC was calculated with the following formula: $(FP2/H2)-(FP1/H1)$ where: FP1 or FP2=number of falsely recognized stimuli (false positives) in run1 or 2 and H1 or H2= number of correctly recognized items (hits) in run 1 or 2.

Norms/properties: There are no norms available. However the mean and standard deviation of the performance on this task by 10 healthy participants were available from the authors (\bar{x} =0.11 (SD 0.10), max=0.28) (Schnider et al., 1996). The authors recommended obtaining our own norms (A. Schnider, pers. comm.). The present 6 healthy controls obtained similarly low scores on this task (\bar{x} =0.06 (SD 0.11); maximum score =0.16)

Comments: The second run in this task could potentially lead to the production of a large number of responses which are guesses. Therefore this task may be subject to the effects of response bias³. Schnider and colleagues argued that the TCC formula controls sufficiently for effects of response bias, because false positives are expressed as a proportion of hits. However to date response biases in this task have not been formally investigated. In a later publication Schnider claimed to have isolated the effects of pure memory in TCC from those of response bias using measures derived from signal detection theory (Schnider, 2008, p.240). However he did not give details of such calculations.

Altman Self-Rating Mania Scale (ASRM) –mania subscale (Altman et al., 1997)

Rationale: This self-rated questionnaire was used to measure level of elated mood in the present sample. The self-rated modality was chosen over other

³ Response bias is the tendency to give either mainly 'yes' replies or mainly 'no' replies to the question: 'have you seen this item before?' during a recognition memory task. The tendency to give mainly 'yes' replies is referred to as 'liberal response bias' and the tendency to give 'no' replies is referred to as 'conservative response bias'.

clinician-rated scales because while potentially less accurate, it nevertheless provides a more direct insight into participants' own view of their mood.

Properties: This scale is significantly correlated with Mania Rating Scale and with the Clinician-Administered Rating Scale for Mania. Test re-test reliability is reported as significant. Scores greater than 5 have 85.5% sensitivity and 87.3% specificity of detecting hypomania ([Altman et al., 1997](#)).

Comments: the raw score of this measure was used as an independent variable in studies 1 and 2, in order to predict presence and clinical course of confabulation respectively.

Hospital Anxiety and Depression Scale (HADS), ([Zigmond and Snaith, 1983](#))

Rationale: this self-rating scale was used for measuring levels of anxiety and depressed mood in our sample. This was chosen over other scales (e.g. Becks or Hamilton depression scales) because the HADS is tailored to people with physical problems, so that symptoms like fatigue do not raise the depressed mood score. In addition, norms for the HADS have recently been described specifically for the brain injury population ([Dawkins et al., 2006](#)).

Norms: a raw score of 10 or higher indicates presence of clinical depression ([Dawkins et al., 2006](#); [Zigmond and Snaith, 1983](#)).

Properties: internal consistency is significant (correlations range between +0.60 and +0.30, $p < 0.02$ for the depression subscale). The measure is reliable: using

the recommended cut-off point for classifying presence versus absence of depression results in only 1% false positives and 1% false negatives. Ratings on this measure correlate significantly with psychiatric ratings of depression severity ($r_{xy}=0.70$, $p<0.001$). In addition scores obtained with the anxiety and depression subscales are unrelated ($r_{xy}= 0.08$, $p>0.05$). This indicates that each scale measures a specific aspect of mood ([Zigmond and Snaith, 1983](#)).

Considerations: The depression scale raw score was used as an independent variable in studies 1 and 2, in order to predict presence and clinical course of confabulation respectively.

Insight interview (Appendix 2.2):

Rationale & description: Appendix 2.2 shows the instrument that was devised in order to measure awareness of: a) memory and b) well-being and independence in participants.

A ready-made instrument that measured both these aspects was not readily available. For example several insight scales for the brain injured population were considered, but these did not measure awareness of current mood (Patient Competency Rating Scale ([Prigatano and Fordyce, 1986](#)); Impaired Self Awareness and Denial of Disability scales ([Prigatano and Klonoff, 1998](#)); awareness interview ([Anderson and Tranel, 1989](#)); self-awareness of deficits interview ([Fleming et al., 1996](#))).

Several scales considered measured insight for mood in the psychiatric population, but these did not measure brain injury deficits (insight scale (Markova and Berrios, 1992); insight and treatment attitudes questionnaire (McEvoy et al., 1989); schedule for assessing the three components of insight (David, 1990)).

For this reason a semi-structured interview was devised in order to answer the study's questions. This semi-structured interview consists of 7 questions that tap: awareness of neurological condition; awareness of cognitive sequelae and awareness of general well-being.

Scoring: Patients' answers were scored according to how well they corresponded with reality, as verified by clinicians and relatives. A correct answer attracted a score of 0; an incorrect answer attracted a score of 2; an answer that indicated partial insight attracted a score of 1. Interview questions and scoring principles are given in Appendix 2.2.

Comments: The raw score of this measure was used as an independent variable in studies 1 and 2, in order to predict presence and clinical course of confabulation respectively. The measure used in this study has not been formally tested for its psychometric properties. It was developed on the basis of clinical experience of the poor insight that is often seen in those with confabulation. It was agreed that if the measure was found to have predictive value, then this would suggest it would be worth examining the measure's properties in more detail at a later stage. However the development of a new measure of insight and examination of its psychometric properties were not

within the remit of this thesis. The main danger of this approach is that a false negative is obtained, i.e. that the new measure fails to identify an association between insight and confabulation that would have been found if a measure with better psychometric properties had been used.

2.3.2. Screening measures chosen in order to allocate participants to different groups

Dalla Barba confabulation battery - episodic section

Description/ rationale: this is a subscale of the Dalla Barba confabulation battery described above. This measure was chosen as one of the criteria for allocating participants to the confabulating or non-confabulating group.

Comments for confabulating participants: There are no accepted norms for this measure. Studies available at the time of writing this study's proposal indicated confabulators produced most false statements in the episodic section ([Dalla Barba, 1993b](#)). For example a participant produced 47% confabulations in the episodic section (i.e.: 7 out of the 15 questions in this section) ([Dalla Barba, 1993a](#)). Another participant gave 8 confabulatory answers to the episodic section alone ([Kopelman et al., 1997](#)). In view of this a cut-off of 8 confabulations in the episodic section was used as one of the criteria for including patients in the confabulating group.

Comments for non-confabulating participants: Recruitment of non-confabulating brain injured participants was based primarily on reports from clinicians

indicating absence of confabulations. Despite lack of observed confabulations, some of these patients gave confabulatory answers to some items of this battery. These were mainly minor or trivial detail inaccuracies (e.g.: reporting what one had eaten at lunch instead of supper time the day before in hospital). Burgess & Shallice (1996) found that healthy participants made up to 5 confabulatory errors in 14 questions about personal episodic events. In order to provide sufficient differentiation between the present study's groups, a cut-off of less than 5 confabulatory responses in the episodic section the Dalla Barba interview was adopted for the non-confabulating group.

Mini Mental State Examination (MMSE) (Folstein et al., 1975)

Rationale: This measure was chosen in order to exclude from the study participants who were in confusional states, or had very severe generalized cognitive impairment. This measure was also used to match the current study's 2 patient groups according to severity of cognitive deficits following their neurological condition.

Description: This is a brief screening test to measure severity of confusion or cognitive decline. It taps orientation, memory, dysphasia, apraxia, and executive function.

Properties: The MMSE has high test-retest reliability ($r_{xy}=0.83$). Concurrent validity was also high when correlated with WAIS-Verbal and Performance IQ ($r_{xy}=0.78$, $p<0.0001$ and $r_{xy}=0.67$, $p<0.001$ respectively) (Folstein et al., 1975).

Scoring: Folstein et al ([1975](#)) scoring guidelines were followed. A cut-off point was specified (a score of 15 or below) in order to exclude people in confusional states, or with severe generalized cognitive impairment (note that a group who had been diagnosed with dementia obtained a mean score of 9.6 (SD 5.8) on this measure) ([Folstein et al., 1975](#)).

Wechsler Memory Scale–III (WMS-III): Logical Memory-delayed subtest (LM2) and Visual Reproduction-delayed subtest (VR2) ([Wechsler et al., 1997b](#))

Rationale/description: These tests were chosen in order to measure delayed recall across verbal and visual domains. LM2 measures the ability to retain auditory information after a delay of 20 minutes. VR2 measures delayed memory for designs.

Scoring: Raw scores were converted to scaled and percentile scores using the manual for this battery of tests ([Wechsler et al., 1997b](#); [Lichtenberger et al., 2001](#)).

Norms: These tests have international highly robust norms ([Wechsler et al., 1997b](#)). They are widely used in clinical practice as a measure of memory function.

Comments: These tests' scaled scores were used in study 1 to ensure that both patient groups were matched in terms of severity of amnesia. They were also

used to describe the sample's level of memory functioning for acquired non-autobiographical information.

2.3.3. Background cognitive tests chosen to describe the sample

Premorbid cognitive ability

The Revised National Adult Reading Test (NART-R) ([Nelson and Willison, 1991](#)) was used to estimate premorbid intellectual ability. Scoring was done according to the manual. Raw NART-R scores were converted to WAIS-III IQ scores using both tests' manuals ([Nelson and Willison, 1991](#); [Tulsky et al., 1997](#)).

Current cognitive ability

The Wechsler Abbreviated Scale of Intelligence (WASI, [Wechsler, 1999](#)) was used to calculate current level of intellectual ability across domains, i.e.: general verbal and non-verbal reasoning, and abstract thinking.

Scoring: This was done following the manual. Raw scores of the 4 subtests were converted into a general IQ score accordingly ([Wechsler, 1999](#)).

Norms: These tests have international highly robust norms ([Wechsler, 1999](#)). They are widely used in clinical practice as a measure of cognitive function.

Comments: In a small minority of cases IQ was derived from WAIS-III, because this had been administered for clinical purposes before patients were referred to the study, and administration of WASI would have resulted in inflated IQ scores due to practice effects ([Wechsler et al., 1997a](#); [D. Mockler pers.comm.](#)). One confabulating participant was not able to carry out any of the above tests; his IQ was derived from the Raven Progressive Matrices – Colour version ([Raven et al., 1984](#)).

The use of different measures to calculate IQ might have introduced a bias to the present data ([Axelrod, 2002](#)). As a precautionary measure an analysis of differences using only WASI IQs was carried out. Results did not differ from those reported in chapter 3 of this thesis. (for details see Appendix 2.3 ‘supplementary WASI analysis’). This indicated the present results had not been significantly altered by the use of different IQ measures on a small subsample.

Speed of processing

The Speed and Capacity of Language Processing (SCOLP) and the WAIS-III digit symbol subtest were used to measure verbal and non-verbal speed of processing respectively.

Scoring: was done according to each test’s manual. Scaled and percentile scores were obtained from the manuals ([Baddeley et al., 1992](#); [Wechsler et al., 1997a](#); [Kaufman and Lichtenberger, 1999](#)).

Memory for personal information ([Kopelman et al., 1990](#))

The childhood, adult and recent episodic events sections of the Autobiographical Memory Interview (AMI) were used to measure memory for personal autobiographic information. The content of participants' answers to this interview was used in study 3 to evaluate affective content of true and false memories.

Scoring: The manual's guidelines were applied only to the information that was independently verified by participants' relatives. Confabulated information did not attract any points ([Kopelman et al., 1990](#)).

Memory for non-personal material ([Wechsler et al., 1997b](#))

The following subtests from the Wechsler Memory Scale III (WMSIII) were used to measure anterograde memory:

- The Logical Memory subtests were used to measure: immediate recall (LM1), delayed recall (LM2) and recognition of *verbal* material respectively.
- The Visual Reproduction subtests were used to measure: immediate recall (VR1), delayed recall (VR2) and recognition of *non-verbal* material respectively.

Scoring: The manual's instructions for scoring and obtaining raw, scaled and percentile scores were followed ([Wechsler et al., 1997b](#); [Lichtenberger et al., 2001](#)).

Memory for non-personal highly emotional material (Adolphs et al., 1997)

Rationale: It has been argued that personal motivational biases influence confabulations and autobiographical memory retrieval in the context of poor memory (Fotopoulou, 2010; Metcalfe et al., 2010). However it is not clear whether these biases are specific to confabulation or whether they reflect deficits processing emotional memories of any type, not just confabulations. Only two types of memory have been investigated in confabulators: a) personal highly emotional memories or b) memory for non-personal non-emotional material. In order to explore the possibility that affective biases found in confabulations may be related to anomalies in the affective processing not only of personal memories but also of non-personal memories, it seemed important to measure memory for non-personal material with high affective content. The Cahill task was used to measure: a) ability to detect emotional content in highly emotional material of a non- autobiographical nature, and b) recognition memory for highly emotional material of a non-personal nature.

Procedure: 11 photographs and a narrative conveying an emotional story were presented to participants. The story revolved around a child who was taken by his mother to visit his father's place of work. On the way they were involved in a road traffic accident and the child had to undergo surgery. The stimuli contained one highly emotional photograph embedded within ten relatively neutral photographs. This photograph has been described as 'gruesome' by some authors, as it depicts the legs of the child after surgery. At the end of the presentation participants were asked to rate how emotional they found the story and photographs. They were also administered a 76-item multiple choice

recognition test, which consisted of 5-9 questions per photograph. Items included questions about both the narrative and the pictures.

Scoring: a) Emotionality ratings: these were self-reported ratings on how emotional participants found all the photographs and accompanying story on a scale of 1-10 (where 0= no emotional at all, and 10= extremely emotional). This score indicated whether the individual was able to detect emotional content in the stimuli presented. b) Emotional recognition score: this was the proportion of items correctly recognised from the questions relating to the critical (highly emotional) photograph. c) Recognition score for neutral material: this was the mean proportion of items correctly recognised across the ten neutral photographs.

Norms: Although no norms exist for this task, it has been used with several populations, including: healthy, brain injured, amnesic participants, and with patients who have suffered Alzheimer's disease, or amygdala damage. An advantage remembering emotional over non-emotional material has been reliably found with all these groups of participants except for patients with amygdala damage. All participants reported similar emotionality ratings ([Cahill and McGaugh, 1995](#); [Adolphs et al., 1997](#); [Hamann et al., 1997](#); [Kazui et al., 2000](#)).

Table 2.6 shows the scores obtained by each group with this task in previous studies.

Table 2.6. Cahill Task. *Emotional rating scores and recognition scores (for emotional and neutral material) obtained by participants with varied pathology reported in several studies.*

Pathology	Emotional rating (0-10)	Emotional recognition score	Neutral recognition score
Healthy	5 ¹ -8 ²	0.9 ^{1,2}	0.5 ^{1,2}
Brain injury	5 ¹	0.8 ¹	0.5 ¹
Bilateral amygdala damage	6 ¹	0.4 ¹	0.5 ¹
Amnesia	8 ²	0.7 ²	0.4 ²

¹(Adolphs et al., 1997); ² (Hamann et al., 1997)

Executive function

A range of tests were used to measure this complex group of functions:

The Cognitive Estimates Test (CET) was used to measure ability to make complex mental calculations and estimations. Raw errors and percentile scores were obtained following published guidelines (Hodges, 1994; Shallice and Evans, 1978).

The Trail Making Test – part b (TMTb) was used to measure cognitive flexibility. Raw timing and percentile scores were obtained following guidelines published (Spreeen and Strauss, 1998; Tombaugh, 2004).

The Hayling Test was used to measure: a) ability to initiate a sequence of action (H1), b) impulsivity (Hb), and c) ability to inhibit irrelevant responses (Hb-errors) (Burgess and Shallice, 1997).

The Brixton Test was used to measure rule detection ability. The Hayling & Brixton Manual guidelines were followed for scoring and obtaining raw, scaled and percentile scores ([Burgess and Shallice, 1997](#)).

2.4. MATERIALS

In addition to the tests and tasks described above the following equipment was used.

In order to carry out Schnider's TCC task a Mackintosh laptop computer with Operating System 9 was used. In addition, the software devised by Schnider for this purpose ('Recory: the ultimate recognition memory experiment', ©Schnider 94-95) was used with the specifications mentioned in the TCC task section above.

Windows Office software packages were used in order to store data. The statistical analysis software package 'SPSS' versions 15 – 18 was used to analyse the data. A personal computer (Fujitsu Siemens 'Esprimo') running Windows XP and Pentium 4HT was used to run the above mentioned software packages.

2.5. PROCEDURES

General procedures are presented here. Specific procedures are presented under each experimental chapter.

2.5.1. Consent and recruitment procedures

This study was granted a favourable opinion by the London Multicentre Ethics Committee (MREC). Only two substantial amendments were requested: one to increase number of confabulating participants to be recruited at an early stage of the illness, and the other to ensure the project complied with the new Mental Capacity Act (2005). R&D approval was individually sought and granted by each participating site, and the investigator held substantive or honorary contracts with all recruitment sites involved. Where a participant moved to a location outside the NHS, the investigator successfully obtained clearance to follow up the participant as required by the individual organization. Annual reports were regularly submitted to the MREC and all R&D departments involved. In addition this study successfully passed an audit by Camden R&D department. Furthermore, the investigator carried out numerous presentations to staff at the various locations and liaised regularly with responsible clinicians regarding the progress of the study in relation to individuals as required by each institution.

Confabulating participants

In the first instance clinicians contacted the researcher if any of their patients displayed 'observable' confabulations. The researcher then checked with the clinician that the patient met criteria for the study and whether they were able to give informed consent. If appropriate, the clinician then provided the participant with information about the study and obtained permission for the investigator to approach the patient. If the patient lacked capacity to consent, their next of kin was also approached at this stage and given a dedicated information sheet

about the study. The investigator then scrutinised available evidence of confabulation in medical notes, and through interview. At this interview the participant's queries were answered, formal consent was sought and, if appropriate, a first assessment commenced. The researcher then contacted the participant's chosen informant and checked the veracity of the participant's answers.

Non-confabulating brain injured participants:

Clinicians alerted the investigator to any of their non-confabulating patients with very poor memory (e.g. memory performance, as tested for clinical purposes, at or below the 5th percentile). Consent was obtained using the same procedure as above. The researcher then excluded participants if confabulations were observed during interview (e.g. 5 or more confabulations in response to interview questions). Participants were also excluded from the study if they were not matched to the experimental group on memory function (LM2 and VR2) or severity of cognitive impairment following brain injury (i.e. MMSE score).

Healthy participants:

The investigator approached relatives or carers of patients at BIRU out-patient clinic and gave them an information sheet. If the carer was agreeable, the investigator then answered any queries and interviewed the person briefly to check they met inclusion criteria. If they did, the investigator obtained formal consent and started study procedures.

2.5.2. Testing procedures

Testing usually took place in a quiet room with a desk or table. Participants were given as much help to complete tasks as they required, as indicated by individual tests' guidelines. Care was taken that tests did not interfere with each other during any one session. For example a delay between two parts of a *visual* memory task was filled with *verbal* tasks or questionnaires. A brief overview of procedures followed in each study is summarised below.

Study 1 – Cross sectional investigations

In study 1 potential associates of the presence of confabulation were investigated. Three groups of participants were compared on experimental measures. In addition, confabulating and non-confabulating brain injured amnesic patients were compared on background cognitive measures. General testing procedures followed for each group are presented below.

All participants: Experimental tasks (TCC and mood measures) were administered to individuals from all groups and were carried out in a single session. Within the same session healthy controls also completed a shortened confabulation interview (semantic, episodic, general knowledge, and orientation sections of the Dalla Barba interview ([Dalla Barba, 1993a](#))).

Patients only: Background and group allocation measures were not repeated if they had already been administered for clinical purposes within 3 months of inclusion in the study. Background cognitive measures and 3 interviews: the

insight questionnaire, the Dalla Barba confabulation interview (Dalla Barba, 1993a) and the Autobiographical Memory Interview (AMI, Kopelman et al., 1990) were carried out in several sessions of up to one hour duration. Patients' answers to the 3 interviews were verified against information from their medical records, the clinical team and their close relatives.

The total testing time for healthy controls was approximately 45 minutes. The total testing time for patient groups ranged 3 to 5 hours depending on the person's cognitive speed.

Study 2 – longitudinal investigations

In this study potential predictors of the clinical course of confabulations were examined. In order to do this 24 confabulating patients were followed up over approximately 9 months. Experimental and cognitive background measures were repeated 3 months after their initial assessment and again 6 months after that.

Study 3 – Affective valence of confabulations

In this study the affective content of true and false memories reported by 24 confabulating brain injured participants was examined. In order to do this, patients' answers to selected sections of the two autobiographical interviews: the Dalla Barba interview (Dalla Barba, 1993a) and the AMI (Kopelman et al., 1990) were transcribed. Each answer was rated by independent judges on a scale of 1-7 according to their pleasantness. The affective content of

confabulations was examined in relation to: a) the 'real' events they had replaced and b) correct or 'true' memories reported by participants.

2.6. ANALYSES

Study 1 – Cross sectional investigations

In this study potential predictors¹ (or concurrent associates) of confabulation were investigated. First ANOVA or t-tests, with group membership as the independent variable (confabulating patients, non-confabulating patients and healthy participants), were used in order to check for differences along confabulation, TCC, insight, mood and relevant background cognitive variables. Kruskal-Wallis chi square and Mann-Whitney U tests were used where parametric assumptions were not met. Where appropriate the Holm's Bonferroni correction for multiple comparisons was used ([Walsh, 2004](#)). This correction method was selected over others when it was unclear whether the multiple tests carried out were truly independent from each other. In this correction method significant comparisons are ordered according to their p values from the smallest to the largest. The critical alpha for the first comparison is: 0.05 divided by the total number of comparisons. Subsequent critical alphas are calculated in the same way, each time subtracting 1 from the number of comparisons used in the previous term.

Next the value of TCC, mood, and insight as concurrent associates of the presence of confabulation was examined. In order to do this, first patients were

¹ Please note: throughout study 1 – cross-sectional investigations: the term 'predictor' is used in its statistical sense, usually in order to refer to concurrent associates.

classified as confabulating or not confabulating according to their score on the episodic section of the Dalla Barba confabulation battery. Then a backward stepwise binary logistic regression analysis was carried out with group membership (confabulating or not confabulating) as the dependent variable and TCC, mood and insight as covariates.

Finally the sensitivity and specificity of the resulting model of predictors (or concurrent associates) of the presence of confabulation was examined. For this, first the regression values of the predicting variables identified in the previous analysis were used to combine these predicting factors into one single variable. Then the ROC curve of this joint variable was drawn using SPSS and the area under the curve examined in order to determine sensitivity and specificity to predict the presence of confabulation.

Study 2 – Longitudinal investigations

In this study the predictors of change in confabulation were explored. In the first instance trend analyses were employed to explore changes in confabulation, TCC, insight and mood along the 3 follow-up assessments. Second, the relative contribution of initial TCC, insight and mood scores in predicting changes in confabulation was explored. For this analysis first, a linear regression was used to calculate the slope of change in confabulation over the 3 assessments for each patient. Then a linear regression analysis was carried out with slope of change in confabulation as dependent factor and initial scores of TCC, mood, and insight as predictors. Backward stepwise selection was used to reduce the model to just those factors making an independent contribution to the prediction

of change in confabulation. Two measures of confabulation were used: a) overall confabulation and b) episodic confabulation.

Study 3 – Affective valence of confabulations

In this study the affective content of confabulations was examined compared to a) the 'real' events that the confabulations had replaced, and b) true memories reported by participants. In order to do this, first independent judges rated true and false memories produced by the present experimental group according to their pleasantness. Next the relative proportions of confabulations rated as either pleasant, neutral or unpleasant - compared with the 'real' facts they had replaced - were examined using one-way repeated measures ANOVA.

Second, related samples t-tests were used to compare a) the proportion of confabulations and true memories with affective content and b) the proportion of pleasant confabulations and true memories among memories with affective content.

Third, the correlation between memories' affective valence and mood state was examined using Kendall's tau.

Finally the effects that focal ventro-medial pathology may have had on affective biases of confabulations were explored. For this purpose the affective ratings of 2 groups: (i) patients who had suffered focal ventro-medial frontal pathology (VMFC), and (ii) those without focal damage to this critical area were examined using a repeated measures ANOVA with lesion site (focal VMFC, or no focal

VMFC) as the between factor, type of memory (confabulation or true memory) as the within factor and proportion of affective memories as the dependent factor.

Chapter 3

Study 1 - Associates of the presence of confabulation (Cross-sectional investigations)

3.1. INTRODUCTION

The main aim of this study was to explore potential predictors¹ (or concurrent associates) of the presence of confabulation. Two sets of measures were considered: a) a comprehensive battery of background cognitive tests and b) the following experimental variables: temporal context confusion (TCC), measures of depressed or elated mood, and a self-reported measure of insight

As was discussed in chapter 1 of this thesis, the correlates and determinants of confabulation are still unclear. Most studies of confabulation have been carried out as single cases and have included comprehensive background cognitive information of participants. In this connection, comprehensive neuropsychological data was collected from the present sample. In addition, a number of theoretical models explain confabulations as a combination of memory and executive deficits ([Moscovitch and Winocur, 2002](#); [Burgess and Shallice, 1996](#); [Kopelman, 1999](#); [Gilboa, 2010](#)). Therefore comprehensive information about participants' memory and executive functioning was collected.

¹ Please note: throughout study 1 – cross-sectional investigations: the term 'predictor' is used in its statistical sense, usually in order to refer to concurrent associates.

As described in chapter 1, a series of elegant experiments by Schnider and colleagues compared spontaneous confabulators to amnesic controls ([Schnider et al., 1996, 2000a; Schnider and Ptak, 1999](#); see [\(Schnider, 2001 & 2008](#) for reviews). They found only one feature distinguished the 2 groups: their performance on a continuous recognition task, making this measure potentially a prime diagnostic tool. Confabulating participants failed to determine the temporal source of some stimuli presented in this task. Therefore the authors concluded that the key cognitive mechanism underlying confabulation was ‘temporal context confusion (TCC)’. TCC was described as a deficit ‘filtering’ incoming memories that pertain to ongoing reality; or more specifically, a deficit suppressing memories that no longer correspond to the present. This explained why confabulators appeared to ‘live in the past’, and were so convinced of their false memories that they acted upon them ([Schnider, 2008](#)).

The above findings have been partially contested by Gilboa et al. ([2006](#)). They used the TCC task to compare a group of confabulators with patients who had suffered anterior communicating artery aneurysm (ACoA), amnesic patients with lesions in the medial temporal lobe and with healthy controls. Consistent with Schnider and colleagues’ results, confabulating patients’ performance on the TCC task was worse than that of healthy controls and amnesic patients. However the task did not discriminate between confabulating and non-confabulating ACoA patients. Gilboa et al. ([2006](#)) concluded that whilst TCC may be sensitive to confabulation, it was not specific to this condition.

In addition to the above controversial findings regarding TCC, Schnider and colleagues’ results have only been replicated with small samples. Therefore it

seemed important to include TCC in the present study in order to investigate whether TCC was associated with the presence of confabulation.

To date explanatory models of confabulation have concentrated on cognitive factors. However there is mounting evidence that confabulations are to certain extent influenced by mood and emotion (Fotopoulou, 2008; Metcalf et al., 2010). Moreover, several authors have found that confabulations may present the individual to others in a favourable or idealised light (Fotopoulou, 2010; Turnbull et al., 2004b). In this way confabulations may somehow help the individual cope with a rather depressing reality (e.g.: being in hospital, loss of job, status, etc). Indeed there is some indication that confabulations may be related to depressed mood, although further research on this topic is required (Fotopoulou et al., 2008b; Metcalf et al., 2010). Thus one of the aims of the present study was to explore whether depressed mood was associated with the presence of confabulation.

On the other hand, clinical evidence suggests confabulators present with poor insight and mild elation. For example, Weinstein & Kahn found the majority of their confabulators were elated and lacked insight (Weinstein and Kahn, 1950). Tiling (1892) and Benon & LeHuche (1920) each described a patient who lacked insight into his condition and was highly elated (both cited in Schnider, 2008). Lack of insight is also considered an integral characteristic of the syndrome of confabulation in some theoretical models of confabulation (e.g. (Burgess and Shallice, 1996). However level of elated mood and insight have not been formally measured in previous studies of confabulation. Therefore

another aim of this study was to explore whether limited insight was associated with the presence of confabulations.

Moreover, evidence from studies with psychiatric populations suggests elated mood affects memory (Corwin et al., 1990; Gainotti and Marra, 1994). During a recognition memory task hypomanic patients gave many more false positives than controls, due to their liberal response bias. This reversed when their mood disorder was treated with beta-blockers (Corwin et al., 1990). Several authors have demonstrated the effects of beta-adrenergic activation on memory (Otto and Hanze, 1994; Cahill and Van Stegeren, 2003). Corwin et al. (1990) suggested that beta-adrenergic function may modulate recognition memory when items are not very strongly remembered and the individual is forced to guess. This explained why, when patients' mood was elated individuals were more likely to endorse falsely recognised items. Whereas when levels of elated mood decreased, patients used a more conservative decision making bias to items for which they had no strong memory. Thus another aim of the present study was to explore whether elated mood was associated with the presence of confabulations.

In summary, most authors view confabulation as a combination of deficits of control processes in memory recollection. Some evidence indicates confabulations may be modulated by personal goals, mood and emotion. In particular confabulations may be accompanied by elated mood and lack of insight. Elated mood in psychiatric patients leads to significant false recognition on memory tasks. However, levels of elated mood and insight have not been formally investigated in confabulating patients. Therefore the aims of this study

were to characterise confabulation along cognitive, insight and mood measures, and to investigate potential predictors (or concurrent associates) of the presence of confabulation, and in particular:

1. to explore differences between confabulating and non-confabulating participants in temporal context confusion (TCC);
2. to examine differences between confabulating and non-confabulating participants in level of insight;
3. to investigate differences between confabulating and non-confabulating participants in elated and depressed mood; and
4. to examine the relative contribution of TCC, insight, elated mood and depressed mood in predicting the presence of confabulation.

3.2. METHOD

3.2.1. Participants

Three groups of participants were recruited: (i) an experimental group of 24 confabulating brain injured patients; (ii) a control group consisting of 11 non-confabulating brain injured patients, and (iii) a second control group consisting of 6 healthy participants.

Recruitment procedures have been described in detail in the method chapter; therefore only a summary of key facts is given here. In order to be included in the study patients had to have a primary diagnosis of acquired, non-congenital, non-progressive brain injury (please see Table 2.3 in the method chapter for details). In addition, confabulating patients were selected on the basis of

evidence of observed spontaneous confabulatory behaviour found both in clinical records and on interview. Non-confabulating patients were selected on the basis of evidence of absence of this behaviour from the same sources. Patients were excluded if an informant was not available to verify their autobiographical memories.

As described in the method chapter, the non-confabulating group was matched to the experimental group primarily on memory ability (delayed WMS-III² subtests; (Schnider et al., 1996). In addition they were also matched on severity of cognitive deficits (MMSE²), age and time elapsed between diagnosis and recruitment to the study (please see tables 2.2, 2.4 and 2.5 in the method chapter for details). Healthy controls were matched to the experimental group on age and level of education (please see table 2.2 in the method chapter for details).

3.2.2. Background assessments

As described in the method chapter, the following background neuropsychological tests were carried out:

- the revised National Adult Reading Test (NART-R) as a measure of premorbid IQ (Nelson and Willison, 1991); the Wechsler Abbreviated Scale of Intelligence (WASI) or the Wechsler Adult Scale of Intelligence – III (WAIS-III) as measures of current IQ (Wechsler, 1999; Wechsler et al., 1997a);

² for details of specific measures please refer to the section on background cognitive measures in the method chapter

- the Speed and Capacity of Language Processing (SCOLP) and the WAIS-III 'digit symbol' subtest as measures of processing speed ([Baddeley et al., 1992](#); [Wechsler et al., 1997a](#));
- the Trail Making Test (TMT) ([Reitan, 1958](#)), the Cognitive Estimates Test (CET) ([Shallice and Evans, 1978](#)), and the Hayling & Brixton Tests as measures of executive function ([Burgess and Shallice, 1997](#)).
- the Wechsler Memory Scale–III as a measure of anterograde memory ([Wechsler et al., 1997b](#)); the childhood, adulthood and recent episodic events sections of the Autobiographical Memory Interview ([Kopelman et al., 1990](#)), as a measure of retrograde personal memory, the Cahill emotional story task ([Adolphs et al., 1997](#)) as a measure of memory for non-personal emotionally charged material (a comprehensive description of this task is provided in pg. 75 of this thesis).

3.2.3. Experimental procedures

These have been described in the method section and are only summarised here.

Participants were administered the Dalla Barba ([1993a](#)) confabulation battery adapted for the UK. Their responses were recorded verbatim and verified against information provided by relatives or held in medical records. Healthy participants were given a shortened version of the confabulation battery (general semantic and orientation sections only).

Participants' temporal context confusion (TCC) was measured using Schnider's continuous recognition task (Schnider et al., 2000a). As previously described in the method chapter, (section 2.3.1: Experimental Measures), in the first part of this task, participants were shown drawings of common objects and animals on a computer. They had to discriminate between drawings they had seen only once, and those which were repeatedly presented. In the second part of this task participants had to discriminate between drawings that had repeated in the *first* part and those repeated in the *second* part of the task. In order to calculate TCC the following formula was used: $TCC = (FP2/H2) - (FP1/H1)$ (FP=false positives in run 1 or 2; H=hits in run 1 or 2; (Schnider et al., 2000a).

The Altman Self-Rating Mania Scale (ASRM) –mania subscale (Altman et al., 1997) and the Hospital Anxiety and Depression Scale (HADS) (Zigmond and Snaith, 1983) were used as measures of current mood state. In addition, a semi-structured interview was constructed and used specifically for this study, in order to measure awareness of mood and cognitive difficulties (appendix 2.2 shows the questions and scoring principles used).

3.2.4. Analyses

In order to characterise the cognitive correlates of confabulation, first confabulating participants' neuropsychometric results were described in relation to those of non-confabulating participants. Potentially significant differences between groups were identified (via inspection of means and SD) and examined as appropriate using repeated measures ANOVA or independent samples t-

tests with group membership as the grouping variable. In the interest of minimising the risk of type I errors (false significance), differences between groups were only analysed statistically if the mean scores for the 2 groups were not obviously similar.

Second, the differences on the proportion of confabulations reported on interview by: a) confabulating, b) non-confabulating brain injured amnesic patients, and c) healthy controls were examined. For this, independent measures one-way ANOVA was used with group membership as the between subjects factor. Where only data for 2 groups was available, t-tests were used instead of ANOVA. P-values were corrected for multiple comparisons using the Holm's Bonferroni method ([Walsh, 2004](#)).

Third, differences between the 3 groups on experimental measures (TCC, insight, elated and depressed mood) were examined using ANOVA and Holm's Bonferroni correction for multiple comparisons. Where only data for 2 groups was available, t-tests were used instead of ANOVA. Kruskal-Wallis chi square and Mann-Whitney U tests were used where parametric assumptions were not met.

Finally, potential predictors (or concurrent associates) of confabulation were investigated. For this analysis, first a binary logistic regression was employed. In this regression group membership (confabulating or non-confabulating) was entered as dependent variable, and TCC, insight, mania and depression were entered as covariates. Backward stepwise selection was used to reduce the model to just those variables making an independent contribution to the

prediction (in the statistical sense) of the presence of confabulation. Lastly, a ROC curve of the resulting optimal model of predictors (or concurrent associates) was constructed in order to evaluate its sensitivity and specificity.

3.3. RESULTS

3.3.1. Background measures

In order to characterise confabulation in the context of brain injury, a comprehensive battery of neuropsychological tests was administered to confabulating and non-confabulating brain injured participants on recruitment to the study. These included measures of general reasoning, processing speed, dysexecutive and memory functioning. Results from these neuropsychological assessments and differences between the 2 groups on key background cognitive tests are reported below.

General reasoning and processing speed

Table 3.1 shows means, standard deviations, range, and percentile scores of confabulating and non-confabulating patients on background cognitive reasoning and processing measures. NART and WASI mean scores indicated that their general reasoning abilities had declined from a premorbid average to a borderline level of function at the time of inclusion in the study. SCOLP and Digit Symbol scores indicated reduced speed of processing (below the 5th percentile). Mean percentile and IQ scores indicated no substantial differences between groups on these measures.

Table 3.1. Background cognitive tests. Mean raw scores and percentiles of confabulating and non-confabulating brain injured participants on background cognitive tests.

Test	Group	N	Mean (SD) raw score	Range	%ile
<u>General reasoning</u>					
NART premorbid IQ	confabulating	24	93.8 (15.85)	56-127	-
	Non-confabulating	11	90.6 (7.75)	75-105	-
WASI current full scale IQ	confabulating	24	77.7 (12.70)	56-98	-
	Non-confabulating	11	76.1 (10.78)	55-94	-
<u>Speed of processing</u>					
SCOLP	confabulating	23	22.8 (10.64)	11-47	1 st -5 th
	Non-confabulating	11	27.3 (8.78)	18-42	1 st -5 th
WAIS-III - Digit Symbol	confabulating	24	23.5 (13.82)	0-62	1 st
	Non-confabulating	11	23.4 (13.91)	8-48	1 st
<u>Executive function</u>					
Trail Making Test – B	confabulating	23	254.1 (115.6)	70-589	10 th
	Non-confabulating	11	255.0 (130.9)	126-566	10 th
Cognitive Estimates Test	confabulating	23	14.2 (5.5)	6-27	1 st
	Non-confabulating	11	11.6 (5.7)	3-19	1 st
Hayling Test – Part A timing score	confabulating	24	36.5 (22.6)	3-82	5 th
	Non-confabulating	11	30.4 (28.5)	5-103	5 th
Hayling Test – Part B timing score	confabulating	23	81.4 (47.5)	17-205	10 th
	Non-confabulating	11	80.0 (43.0)	48-167	10 th
Hayling Test – Part C type a & b errors	confabulating	23	40.7 (23.6)	0-78	1 st
	Non-confabulating	11	30.6 (23.3)	3-62	1 st
Brixton Test	confabulating	23	31.1 (10.8)	16-52	1 st
	Non-confabulating	11	28.6 (11.1)	16-49	1 st
<u>Anterograde memory</u>					
WMS-III – Immediate	confabulating	22	12.3 (8.2)	2-30	1 st
Logical Memory	Non-confabulating	11	15.3 (6.8)	6-25	1 st
WMS-III – Delayed Logical Memory	confabulating	22	3.1 (4.3)	0-14	1 st
	Non-confabulating	11	4.6 (4.7)	0-13	1 st
WMS-III – Recognition	confabulating	22	18.6 (3.6)	11-25	-
Logical Memory	Non-confabulating	11	20.5 (2.2)	17-24	-
WMS-III - Immediate	confabulating	21	41.0 (16.7)	4-78	1 st
Visual Reproduction	Non-confabulating	11	49.1 (27.5)	8-83	1 st
WMS-III - Delayed Visual Reproduction	confabulating	21	6.8 (8.9)	0-36	2 nd
	Non-confabulating	11	11.5 (13.6)	0-37	2 nd
WMS-III - Recognition	confabulating	20	34.6 (4.0)	23-39	5 th
Visual Reproduction	Non-confabulating	11	34.7 (7.8)	17-44	5 th
<u>Memory for emotional material: Cahill task</u>					
Emotional rating	confabulating	22	6.3 (3.0)	0-10	-
	Non-confabulating	11	6.5 (2.7)	0-10	-
proportion remembered for the critical slide	confabulating	22	0.4 (0.3)	0.0-0.8	-
	Non-confabulating	11	0.6 (0.3)	0.2-1.0	-
mean proportion remembered for non-critical slides	confabulating	22	0.4 (0.2)	0.0-0.7	-
	Non-confabulating	11	0.4 (0.1)	0.2-0.7	-
Difference scores	confabulating	22	0.0 (0.2)	-0.3-0.5	-
	Non-confabulating	11	0.2 (0.2)	-0.1-0.5	-
<u>Autobiographical Memory</u>					
AMI – episodic – childhood	confabulating	23	5.0 (0.5)	0-9.0	-
	Non-confabulating	11	6.0 (0.7)	2.0-9.0	-
AMI – episodic – young adulthood	confabulating	23	4.9 (0.4)	1.0-8.0	-
	Non-confabulating	11	6.4 (0.7)	2.0-9.0	-
AMI – episodic – recent events	confabulating	23	3.0 (0.5)	0.0-6.0	-
	Non-confabulating	11	5.4 (1.0)	1.0-9.0	-

Executive functioning

Table 3.1 also shows means, standard deviations, range, and percentile scores of confabulating and non-confabulating patients on background tests of executive function. In general all patients' scores showed they had significant difficulties across a range of executive functions; these included flexibility of thought (Trail Making Test), mental estimation (CET), initiating and inhibiting responses timely and adequately (Hayling A&B) and the ability to adapt their behaviour according to external feedback (Brixton). Moreover, they performed at the low average level of function on Hayling B timing score (10th percentile), with increased errors (1st percentile). This indicated difficulties with impulsivity. Mean percentile scores indicated no substantial differences between the confabulating and non-confabulating groups on these measures.

Memory

Table 3.1 shows means, standard deviations, range, and percentile scores of confabulating and non-confabulating patients on background memory tests. Their scores on anterograde memory tests fell below the 5th percentile, indicating they had severe difficulties learning new information. Mean percentile scores indicated no substantial differences between groups on measures of anterograde memory.

The 2 groups' scores on tests of memory for autobiographical and non-personal emotional events (AMI and Cahill task respectively) were markedly different.

Given the nature of this study these were explored further and results are reported below.

Figure 3.1. AMI. *Mean AMI accuracy scores on recruitment to the study. The ‘Ribot’ temporal gradient is evident in both groups: confabulating and non confabulating brain injured patients*

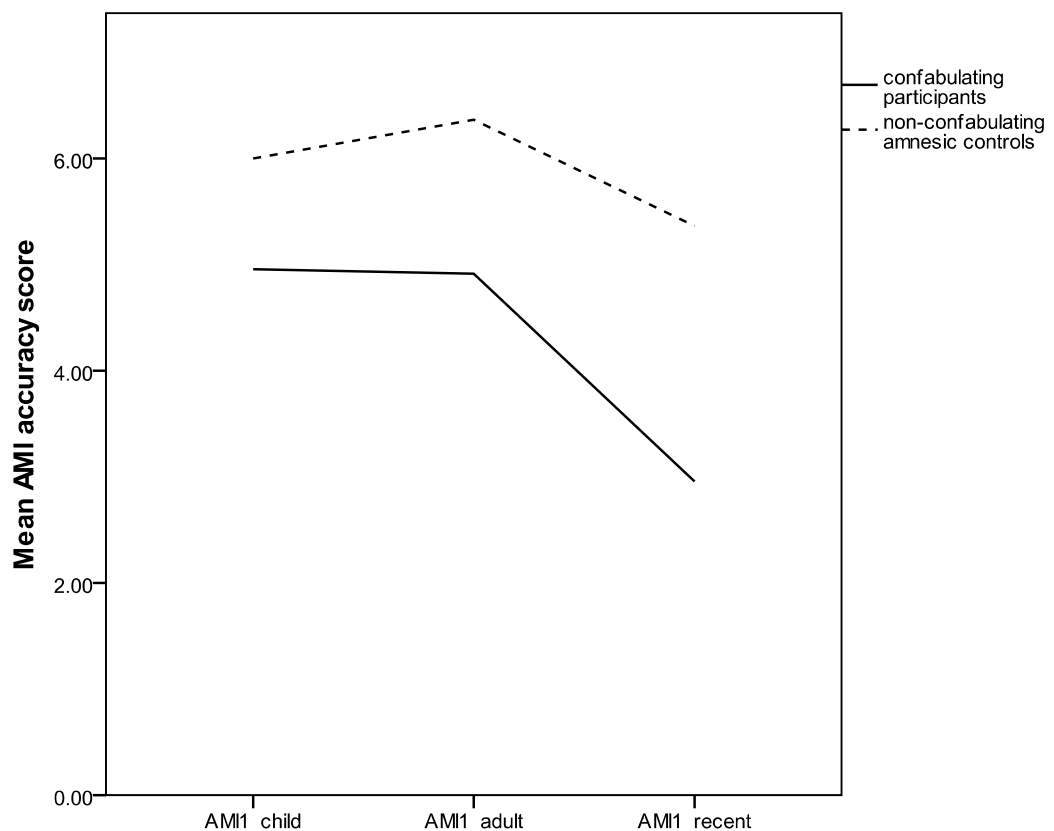


Figure 3.1 shows mean accuracy scores of confabulating and non-confabulating participants on the AMI episodic schedule. Confabulating patients scored at ‘borderline abnormal’ level on the childhood and young adulthood scales of the AMI and at ‘definitely abnormal’ level on the recent events section of this test. Non-confabulating participants performed at ‘acceptable’ level on the childhood scale, but they scored at ‘borderline abnormal’ on the young adult scale and at

'definitely abnormal' on the recent events section. The pattern of performance in both groups is consistent with a temporal (or 'Ribot') gradient (Kopelman et al., 1990).

In order to investigate differences in autobiographical memory function, repeated measures ANOVA with AMI subtest as a within factor (childhood, adulthood or recent) and group as the between factor (confabulating or non-confabulating) was carried out on AMI accuracy scores. Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2(2)=0.735$, $p=0.008$), therefore degrees of freedom were corrected. Since $\epsilon > 0.75$, Huynh-Feldt estimates of sphericity were used to correct degrees of freedom on this occasion ($\epsilon=0.851$). ANOVA results showed a main effect of subtest: $F(1.70, 54.44)=7.003$, $p=0.039$, and a significant effect of group: $F(2, 32)=5.852$, $p=0.021$, indicating that non-confabulating participants obtained higher accuracy scores on the AMI. There was no interaction between subtest and group: $F(1.70, 54.44)=1.30$, $p=0.277$. Planned pairwise comparisons showed that recall of recent events was significantly less accurate than recall of childhood memories (mean difference=1.318, $p=0.047$) and of adulthood events (mean difference=1.478, $p=0.006$), after Bonferroni correction for multiple comparisons. No significant differences were found between recall of childhood and adulthood events (mean difference=0.160, $p=1.00$).

In order to study differences in memory for non-personal emotional material, first, the proportion of information correctly recalled within each Cahill slide was calculated. Second, the mean proportion of information remembered from the non-critical slides was calculated. Third, difference scores were obtained by

subtracting this mean from the proportion of information remembered from the Cahill critical slide (with high affective content). Fourth, parametric assumptions were considered and met; therefore independent groups t-tests were used to compare the 2 groups on Cahill difference scores.

The means on Table 3.1 indicate that both groups showed virtually identical ability to detect emotional content across all the slides presented. However, the confabulating group remembered considerably less *emotional non-autobiographical* material (as measured by Cahill difference scores) than the non-confabulating group ($t(31)=3.426$, $p=0.002$). This is a relatively rare pattern of performance, which has been found only in patients with amygdala damage. It has been associated to an inability to experience the internal emotions that may be elicited by external stimuli ([Adolphs et al., 1997](#); [Tranel et al., 2006](#)).

3.3.2. Confabulation

The next set of analyses was used to compare confabulating and non-confabulating patients with healthy controls on confabulation measures.

Table 3.2a shows means, standard deviations and ranges of the overall proportion of items from the Dalla Barba confabulation battery to which the 3 groups gave confabulatory answers. Proportions used in the analyses were consistent with a normal distribution of data. One-way ANOVA confirmed there were significant differences between the 3 groups on the proportion of confabulations reported in response to the Dalla Barba interview ($F(2,38)=48.42$; $p<0.001$). Bonferroni post-hoc tests indicated that overall the experimental group confabulated to a significantly greater proportion of items on

this interview than both control groups: non-confabulating brain injured participants (mean difference= 0.268; $p<0.001$), and healthy participants (mean difference = 0.310; $p <0.001$).

Table 3.2a. Confabulations. Overall proportion of questions in the Dalla Barba interview to which participants gave confabulatory answers, and proportion of items within the episodic and personal semantic sections of this interview to which participants gave confabulatory answers respectively, as verified by informants and medical records

Test	Group	N	Mean (SD)	Range
Overall proportion of confabulations	confabulating	24	0.4 (0.1)	0.2-0.6
	non-confabulating	11	0.1 (0.1)	0.0-0.2
	healthy	6	0.1 (0.1)	0.0-0.1
Episodic section: proportion of confabulations	confabulating	24	0.6 (0.1)	0.3-0.8
	non-confabulating	11	0.1 (0.1)	0.0-0.3
	healthy	-	-	-
Personal semantic section: proportion of confabulations	confabulating	24	0.4 (0.1)	0.2-0.6
	non-confabulating	11	0.1 (0.1)	0.0-0.3
	healthy	-	-	-

The healthy control group were only administered a short form of the Dalla Barba confabulation battery; they did not answer the episodic nor the personal semantic questions. Consequently only the 2 patient groups were compared on these sections of the interview. Independent measures t-tests showed the experimental group confabulated to a significantly greater proportion of items within the personal semantic and episodic sections than the non-confabulating amnesic control group ($p<0.001$). Table 3.2b shows F or t values and adjusted p values for comparisons between groups on the 3 confabulation measures. All 3 differences remained significant after Holm's Bonferroni correction for multiple comparisons (Walsh, 2004).

Table 3.2b. Adjusted p values. *Adjusted p values for multiple comparisons using the Holm's Bonferroni method (ie: p values are ordered from smallest to largest and critical alpha is calculated dividing 0.05 by a decreasing number of comparisons at each step)*

<i>Null hypothesis tested</i>	<i>Absolute value of F/t (df)</i>	<i>P value</i>	<i>Critical alpha</i>	<i>Null hypothesis rejected?</i>
No differences on Dalla Barba – overall confabulations	F(2,38)=48.42	0.000	0.05/3=0.017	Yes
No differences on Dalla Barba – episodic confabulations	t(33)=8.81	0.000	0.05/2=0.025	Yes
No differences on Dalla Barba – personal semantic confabulations	t(33)=6.61	0.000	0.05/1=0.050	Yes

3.3.3. Experimental measures

The next set of analyses was used to compare the 3 groups of participants: a) confabulating patients, b) non-confabulating brain injured controls, and c) healthy controls on experimental measures, in order to index differences due to confabulation on the one hand, and those due to brain injury on the other hand on TCC, insight score, ASRM elated mood score, and HADS depressed mood score.

Table 3.3 shows means, standard deviations, and range of 3 participant groups on experimental measures. Parametric assumptions were met both for TCC and insight. Elated and depressed mood scores showed a somewhat skewed distribution towards milder severity of symptoms, therefore Kruskal-Wallis chi square tests were carried out.

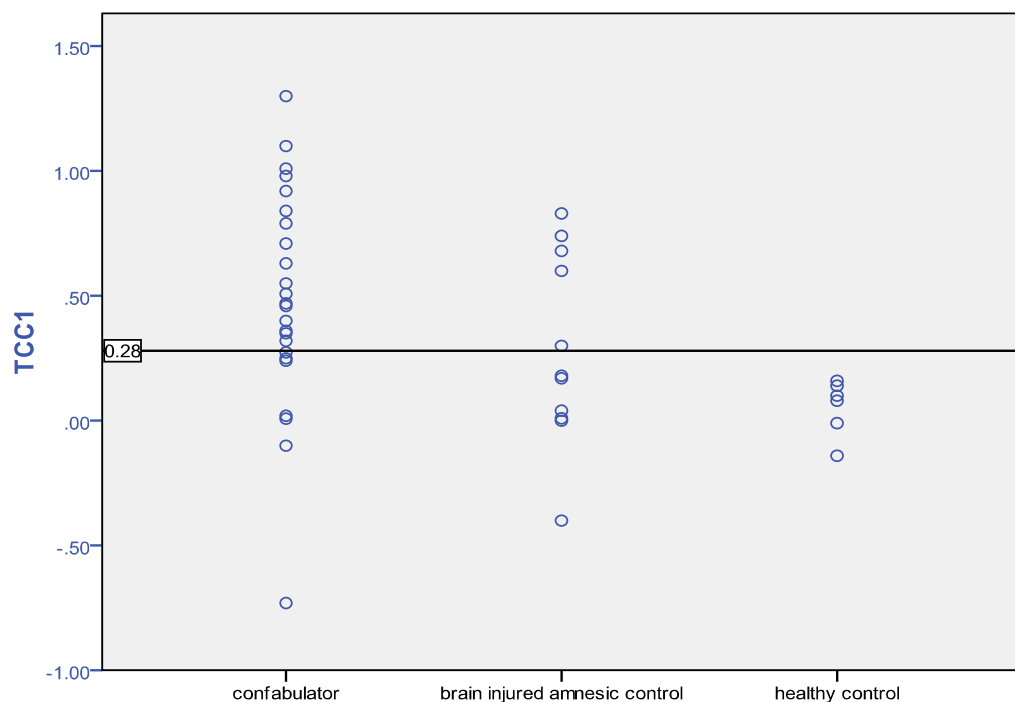
Table 3.3. Experimental tasks. Means, standard deviations and range of scores obtained by each group of participants on experimental measures

Test	Group	N	Mean (SD)	Range
TCC	confabulating	24	0.5 (0.4)	-0.7-1.3
	Non-confabulating	11	0.3 (0.4)	-0.4-0.8
	healthy	6	0.1 (0.1)	-0.1-0.2
Insight	confabulating	23	8.3 (3.4)	1-14
	Non-confabulating	11	5.6 (2.5)	1-9
	healthy	-	-	-
Elated mood	confabulating	23	4.0 (3.3)	0-10
	Non-confabulating	11	1.7 (2.3)	0-7
	healthy	6	3.2 (3.9)	0-10
Depression	confabulating	23	3.4 (2.8)	0-9
	Non-confabulating	11	3.5 (3.2)	0-10
	healthy	6	3.5 (3.5)	1-8

Figure 3.2 shows how individual confabulating participants and non-confabulating controls performed on the TCC task in the current study. The confabulating group and healthy controls performed on this task at similar levels to those reported by Schnider et al. (1996). This is, healthy controls scored below 0.28 on this task, and so did most of the non-confabulating brain injured controls, whereas most confabulating patients scored above this cut-off point. In this way, the current findings partially replicated Schnider et al's (1996).

However, note that 7 confabulating participants failed to perform according to Schnider et al's (1996) predictions and scored below the 'healthy' cut-off.

Figure 3.2. TCC. Scatter distributions of TCC scores for 24 confabulating patients, 11 non-confabulating brain injured amnesic patients, and 6 healthy controls. $TCC = (FP2/hits2) - (FP1/hits1)$. The horizontal line shows the cut-off point reported for healthy controls (0.28) by Schnider et al. (1996)



Moreover, 5 of the brain injured non-confabulating controls also partially contradicted Schnider's results and scored above the cut-off; this was despite being matched to the experimental group on the same variables reported by these authors. The pattern of performance of this group was consistent with that of one of Gilboa et al's (2006) control groups: non-confabulating patients who had suffered an anterior communicating artery aneurysm (ACoA), but not with

the other control group: amnesic participants with medial temporal lesions. This result may reflect the severity of executive dysfunction present both in the current brain injured controls and in Gilboa et al's (2006) ACoA group.

One-way ANOVA results showed that differences between the 3 groups of participants on performance of the TCC task just missed statistical significance ($F(2,38)=3.111$; $p=0.056$). Mean scores of the 3 groups on this measure indicated that while confabulators' performance on this task was considerably worse than that of healthy controls, it was only mildly poorer than that of non-confabulating amnesic controls.

To summarise, in partial agreement with Schnider's findings, TCC scores in the current study did discriminate between healthy and most confabulating participants (but not all). However, consistent with Gilboa's findings (and partially contrary to Schnider's) TCC scores did *not* discriminate between confabulating and non-confabulating *brain injured participants*.

Insight was not applicable to the healthy control group. T-test results for the remaining participants showed the confabulating group had significantly less insight into their difficulties than the non-confabulating group ($t(32)=2.260$; $p=0.031$). However, after adjusting this p value for multiple comparisons, this difference merely approximated significance (critical alpha for 4 comparisons was 0.012).

None of the current participants showed clinically abnormal levels of depressed or elated mood. No significant differences among the 3 groups were found on

depressed scale scores ($\chi^2(2)=0.023$, $p=0.989$). Mean scores indicated that all groups showed similar levels of low mood. No significant differences were found among the 3 groups on elated mood scores ($\chi^2(2)=3.797$, $p=0.151$). However, mean scores indicated the experimental group showed higher levels of elated mood than the non-confabulating group. This was investigated with a Mann-Whitney test. Results indicated this difference approached significance ($U=74.0$, $p=0.049$; 2-tailed). This last analysis was carried out in the interest of providing background to the next analysis.

3.3.4. Potential predictors of confabulation

The next analyses were used to explore whether any of the experimental measures predicted (in the statistical sense) the presence of confabulation. For this, first a binary logistic regression was used to build a model of the best predictors of the presence of confabulation and second a ROC curve was constructed to examine sensitivity and specificity of the model of predictors (or concurrent associates).

Only the 2 patient groups were included in this analysis. For this analysis a binary logistic regression was carried out with group membership (confabulating versus non-confabulating) as the dependent variable and TCC, elated mood, depressed scale score and insight as the covariates. Backward stepwise selection was used to reduce the resulting model to just those variables making an independent contribution to the prediction of the presence of confabulation.

Depression was dropped as a predictor at step 1 ($p=0.931$), and TCC was dropped at step 2 ($p=0.266$).

Table 3.4 shows the resulting model of predictors (or concurrent associates) of the presence of confabulation, which included level of insight and elated mood. According to this model for each 1 unit reduction in insight scores (or in other words an improvement in insight) there are 30% lower odds of confabulating; and for each 1 unit reduction in elated mood scores there are 33% lower odds of confabulating. However, conclusions based on these results should be interpreted with caution as data at the upper end of the 95% confidence interval is consistent with a true reduction in odds of as little as 4% for insight and as little as 1% for elated mood.

Table 3.4. Predictive model. *Final predictive model for the presence of confabulation (using backward stepwise binary logistic regression)*

	Odds Ratio	95% CI for OR		p
		<i>lower</i>	<i>upper</i>	
Insight	0.70	0.50	0.96	0.029
Elated mood	0.67	0.46	0.99	0.042

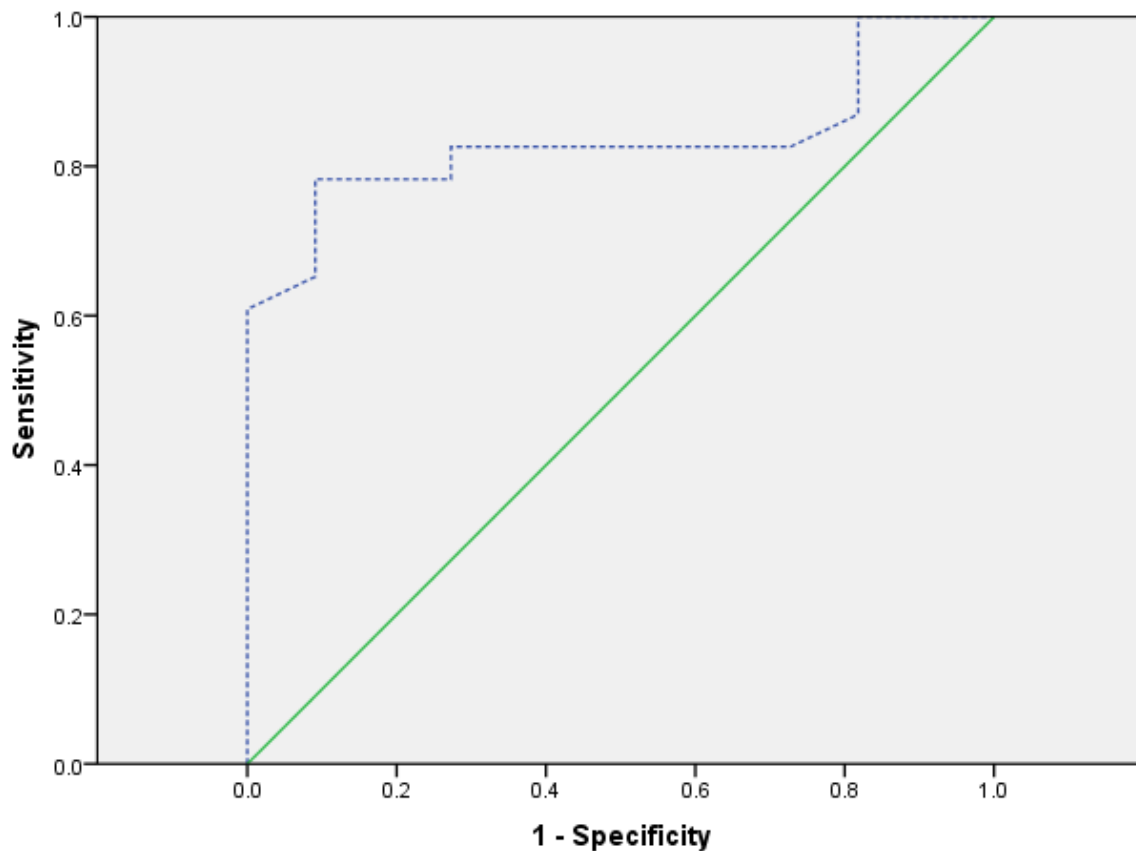
Next a ROC curve was drawn in order to examine the sensitivity and specificity of the above predictive model. For this a joint variable was manually calculated using values extracted from the previous regression analysis. In other words, the regression 'B' values from the best model of predictors: insight and elated mood were extracted (insight $B=-0.361$; elation $B=-0.4$; constant $B=2.77$). The following formula was constructed with these 'B' values and was applied to insight and elated mood scores in order to create a new joint variable: 'fitted

values' = $2.770 + (-0.361 * \text{insight1}) + (-0.400 * \text{elation1})$. Figure 3.3 shows the ROC curve drawn using the joint variable of 'fitted values'.

The area under the ROC curve indicated that there was a 0.834 probability that a randomly chosen confabulator obtained a higher score on insight & elated mood compared to a randomly chosen non-confabulator (the 95% confidence interval for the area under the curve was 0.696-0.972). In other words, the greater the insight difficulties and elated mood, the greater the chances are of being a confabulator.

The coordinates of the ROC curve indicated that with a cut of achieving specificity of 82%, sensitivity of this model of predictors (or concurrent associates) would be 78%.

Figure 3.3. ROC curve of fitted values of insight and elated mood at initial assessment (the butted line represents the fitted values of the joint variable (insight & elated mood) and the single line represents the reference line)



Diagonal segments are produced by ties.

3.4. DISCUSSION

What causes confabulation remains controversial. In particular the role insight and mood play on the appearance of confabulations has been seldom investigated until now. In this study 24 brain injured confabulating patients were compared to two matched control groups: 11 non-confabulating amnesic patients and 6 healthy participants on temporal context confusion (TCC), insight, mood (depression and elated mood), and background measures.

Current results indicated the two brain injured groups of participants showed very similar background cognitive levels of function. The experimental group differed from the non-confabulating amnesic control only in two specific areas: a) they remembered fewer personal events; b) they recalled significantly less non-autobiographic material with high affective content. This was somewhat surprising because brain injured and amnesic individuals and patients diagnosed with Alzheimer's disease have shown a robust advantage recalling this type of information over emotionally neutral material ([Adolphs et al., 1997](#); [Hamann et al., 1997](#); [Kazui et al., 2000](#)).

Overall the present experimental group confabulated significantly more than both control groups; this was true both for episodic and semantic personal information. This is consistent with previous studies where confabulations have been observed in semantic as well as in episodic memory ([Kopelman et al., 1997](#); [Kan et al., 2010](#); [La Corte et al., 2010](#)).

Regarding the first aim of this study, most confabulating patients (but not all) performed considerably worse than healthy participants on TCC, thereby partially replicating Schnider et al.'s ([1996](#)) results. However, in contrast with these authors' findings, performance on TCC showed poor discrimination between confabulating and non-confabulating brain injured amnesic patients. Present results are consistent with those obtained by Gilboa ([2006](#)), in that these authors found that TCC did not discriminate between confabulating and other brain injured non-confabulating patients.

Regarding the second aim of this study, it was also found that the confabulating group had considerably less insight into their condition than the non-confabulating brain injured amnesic group.

Regarding the third aim of this study, the present 3 groups of participants were asymptomatic in terms of mood disorders. There were no differences among them on depression scale scores. Levels of elated mood were considerably higher in confabulating than in non-confabulating patients; however this difference merely approached statistical significance.

More importantly, regarding the fourth aim of this study, current results showed that a combination of increased levels of elated mood and reduced levels of insight into difficulties and well-being predicted the presence of confabulation in the present sample. This model of concurrent associates was sensitive and specific to the presence of confabulation.

In summary the present findings showed that: (i) TCC was sensitive to the presence of confabulation, but it did not predict it in the present sample, and showed poor discrimination between confabulating and other brain injured participants; (ii) a combination of elated mood and poor insight predicted the presence of confabulation in the present sample.

Schnider argued that TCC discriminated confabulators not only from healthy individuals but also from a group of patients matched to confabulators for levels of amnesia. On the basis of this, Schnider concluded that a deficit in updating ongoing reality and suppressing irrelevant memories lay at the root of

confabulation. As Schnider found, the present data showed that confabulating participants performed considerably worse than healthy participants on this task. However, partially contrary to Schnider's findings, current confabulators' performance did not differ significantly from that of non-confabulating brain injured patients matched for levels of amnesia.

Similarly Gilboa (2006) found that although TCC discriminated between confabulating and amnesic participants (with medial temporal lobe lesions), it did not discriminate between confabulating and non-confabulating ACoA patients (who had suffered ventromedial prefrontal cortex damage). The current results would support Gilboa's (2006) conclusion that this task may be sensitive but not specific to confabulation. Gilboa (2010) distinguished between 'core' deficits, necessary and sufficient for the appearance of confabulations, and 'constitutional' deficits, which are not unique to confabulation. 'Constitutional' deficits may be necessary but they are not sufficient for the appearance of confabulation. The present findings would support Gilboa's (2010) conclusion that TCC may belong to 'constitutional', rather than 'core' deficits in confabulation.

A combination of elated mood and poor insight predicted the presence of confabulation in the present sample. These results are partially consistent with Corwin et al.'s (1990) findings with hypomanic patients. Corwin argued that elated mood resulted in an exaggerated willingness to report guesses when an individual was not sure of the answer. If replicated, the present results would suggest that elated mood may have a similar effect on executive processes that

are believed to be responsible for the appearance of confabulations (Gilboa, 2010). These are reviewed next.

According to Gilboa (2010) the breakdown of 'Feeling Of Rightness' monitoring processes leads to accepting false memories with high confidence. In the case of confabulations this may be because autobiographical memories are associated with a high level of confidence in their veracity due to their high significance and personal meaning for the individual. Hence, autobiographical knowledge may play a part in biasing decisions at a pre-conscious level and in guiding behaviour (Conway and Pleydell-Pearce, 2000).

Gilboa also hypothesised that control mechanisms allow a person to regulate the quantity and accuracy of memories reported. This means that irrespective of the conviction with which a memory is held, the individual decides whether to report it or not, depending on the anticipated consequences of their actions. The exaggerated willingness of confabulators to report erroneous memories may be due in part to faulty control processes. Although Gilboa provided a comprehensive explanation of cognitive mechanisms underlying confabulation, he has not considered the effects of mood on confabulation.

If replicated, the present results would suggest that slightly elated mood may contribute to deficits in both 'Feeling Of Rightness' and control processes described by Gilboa (2010) in confabulations. On the one hand elevated mood may promote an exaggerated sense of confidence in false memories; on the other hand it may lower the criterion upon which the person may decide to go ahead and report a (false) memory. Unfortunately neither the present study, nor

Corwin et al.'s (1990) allow to determine at which of these two levels elated mood is likely to operate. To examine this, further investigations should include measures of participants' confidence in their reported memories, and a free narrative task where the participants would have control over whether or not to report (false) memories.

Related to this, Corwin et al. (1990) found that beta-blockers reversed the disproportionate willingness to guess in patients with hypomania. Cahill & van Stegeren (2003) found memory for emotional material was modulated by beta-adrenergic blockade. Schnider (2008) found dopamine antagonists sometimes reduce confabulation. In future it may be interesting to find out whether beta-blockers reduce confabulation in patients with elevated mood.

In terms of insight, this was one of the concurrent associates of the presence of confabulation in the present sample. This is consistent with models of confabulation that include insight as a critical feature (Burgess and Shallice, 1996). The effects of reduced insight on confabulation are still unclear. Some authors have referred to confabulation as a lack of integration between consciousness, identity, memory and perceptions from the environment (Feinberg and Roane, 1997). Other authors have linked confabulations to deficits matching external events to internal predictions (Turner et al., 2008b).

Related to this, failure in the Cahill task has been associated to an inability to experience the internal emotions that may be elicited by external stimuli (associated with amygdala damage) (Adolphs et al., 1997; Tranel et al., 2006). The present confabulating sample remembered considerably less information

from highly emotional non-autobiographical material than the non-confabulating group. They had no difficulty quantifying the affective content of the stimuli; therefore their poor performance on this task could not have been caused by a general defect in processing affect. This would be consistent with Metcalf's ([Metcalf et al., 2010](#)) proposal that confabulating participants do not suffer generalised emotional dysregulation. One possible explanation for confabulators' pattern of performance on this task would be that memories which are not consistent with important goals and self-images may receive less activation than those that are ([Conway, 2005](#)). Whether this pattern of performance is related to specific lesions, or memory control mechanisms in confabulation, or a more general dysfunction of attention mechanisms that integrate internal and external cognition ([Burgess et al., 2007b](#)) are questions that may need to be addressed in future studies.

In conclusion, the present findings partially replicated Schnider's results and showed that TCC discriminated between most confabulating and healthy individuals. However, TCC did not predict the presence of confabulations. Moreover, in partial refutation of Schnider's findings, TCC discriminated poorly between confabulating and non-confabulating brain injured amnesic participants. This was consistent with results obtained by Gilboa with patients with frontal aneurysms. Therefore it is concluded here that whilst TCC may be sensitive to confabulation, it does not seem specific to this disorder. A combination of elated mood and poor insight predicted the presence of confabulation in the present sample with a high degree of sensitivity and specificity. Slightly elated mood in confabulating patients may result in increased confidence on false memories on the one hand, and increased

willingness to report them on the other hand. In this way mood may affect dysfunction within two core processes believed to underlie confabulation: the 'Feeling of Rightness' and Control processes. In summary the present results suggest a previously unreported role of insight and mood on the appearance of confabulation in the current patient sample.

Chapter 4

Study 2 - Predictors of recovery from confabulation (Longitudinal investigations)

4.1. INTRODUCTION

The main aims of this study were to characterise the clinical course of confabulation along cognitive, insight and mood measures and to explore potential predictors of change in confabulation. Two sets of measures were considered: a) a comprehensive battery of background cognitive tests and b) the following experimental variables: temporal context confusion (TCC), measures of elated and of depressed mood, and a self-reported measure of insight.

Very few longitudinal studies have examined the clinical course of confabulations. Most were single cases or had small samples. The nature of the follow-up of confabulations in these studies typically has been limited to behavioural observations ([Mercer et al., 1977](#); [Nahum et al., 2010](#); [Mattioli et al., 1999](#)). For this reason, comprehensive background neuropsychological data were collected longitudinally from the present sample.

Two areas of cognition have been linked with the clinical course of confabulation: memory and executive function, although findings have been contradictory. For example improvements in executive function have been reported both in the context of and in absence of severe amnesia ([Benson et](#)

al., 1996; Kapur and Coughlan, 1980 respectively). Schnider et al. (2000a) found that memory and executive function remained unchanged or worsened in some patients who had stopped confabulating, and conversely, some patients who continued to confabulate experienced memory and executive function improvements. Box et al. (1999) also found that memory and executive deficits persisted beyond recovery from confabulation in a single case, and this patient went on to develop a misidentification delusion. Consequently several authors have argued that explanatory models of confabulation must include a 'dynamic' dimension to account for their clinical course (Box et al., 1999; Fotopoulou et al., 2004). For this reason a comprehensive assessment of memory and executive function was carried out as part of background cognitive testing in the current study.

A previous investigation with the present sample (see chapter 3 in this thesis) identified significant differences between confabulating and non-confabulating participants on two background cognitive measures: (i) autobiographical memory and (ii) memory for non-personal emotional material. Therefore changes over time in background cognitive measures were examined in the present study with particular attention to these two areas of function.

Several models have attempted to identify the critical cognitive mechanisms underlying the appearance and course of confabulations. These have been comprehensively reviewed recently (DeLuca, 2009; Fotopoulou, 2010; Kopelman, 2010; Schnider, 2008). Of particular relevance to this study is a model that has attempted to explain not only the cause of behaviourally

spontaneous confabulations but also their clinical course (Schnider, 2008; Nahum et al., 2010).

Schnider (2008) found that performance on the TCC task improved as patients recovered from confabulation. Since no other cognitive measure studied paralleled recovery from confabulation, TCC was put forward as a critical cognitive mechanism underlying confabulation (Schnider et al., 2000a; Nahum et al., 2010). However, these findings have not yet been replicated by investigators outside Schnider's team. In this respect, results reported in the previous investigation (see chapter 3 in this thesis) provided partial support for Schnider's hypothesis. They showed that TCC was indeed sensitive to the presence of confabulation in the current sample. In the present investigation, confabulating participants' changes in TCC performance were charted over time, and the relative contribution of TCC in predicting changes in confabulation was examined.

Most of the previous studies have not taken mood and insight into account, and none has measured them formally. However, there is evidence that emotion and/or insight modulates confabulation. Several authors have described confabulation in the context of lack of insight and elated mood or even hypomania (Weinstein and Kahn, 1950; Schnider, 2008). Furthermore evidence suggests that recovery from confabulation may be accompanied by increased awareness of amnesia and confabulation (Feinberg and Roane, 1997; Mercer et al., 1977; Nahum et al., 2010; DeLuca, 2000).

Related to this, elated mood has been found to modulate memory in psychiatric populations ([Corwin et al., 1990](#); [Gainotti and Marra, 1994](#)). Elated mood has been linked to a liberal bias in patients' responses to recognition memory tasks. More importantly this bias disappeared when patients recovered from the underlying mood disorder ([Corwin et al., 1990](#)). Taken together these studies would suggest that elated mood and/or level of insight may modulate the appearance and clinical course of confabulation. Furthermore, results from a previous study indicated that insight and elated mood were the best concurrent associates of the presence of confabulation (see chapter 3 in this thesis). Therefore, in the present investigation, confabulating participants' changes in insight and elated mood were charted over time, and their relative contribution to the prediction of changes in confabulation was examined.

In this connection, the content of confabulations has been found to be highly affective and often pleasant in nature ([Burgess and McNeil, 1999](#); [Fotopoulou, 2010](#); [Metcalf et al., 2010](#)). This has been taken to indicate that affective or emotional mechanisms may modulate the content of confabulations ([Fotopoulou, 2010](#); [Metcalf et al., 2010](#); [Gilboa, 2010](#)). One hypothesis put forward was that emotion and personal goals exert an exaggerated bias on confabulators' autobiographical memory retrieval; this would be caused by breakdown of memory and critical monitoring processes ([Gilboa, 2010](#); [Conway and Pleydell-Pearce, 2000](#); [Fotopoulou, 2010](#)). Moreover, several authors have found that confabulations may present the individual to others in a favourable or idealised light ([Fotopoulou, 2010](#); [Turnbull et al., 2004b](#)). In this way confabulations may somehow help the individual cope with a rather depressing reality (e.g.: being in hospital, loss of job, status, etc). Indeed there is some

indication that confabulations may be related to depressed mood, although further research on this topic is required (Fotopoulou et al., 2008b; Metcalf et al., 2010). If this explanation were verified, then confabulating individuals might be expected to be suffering from low mood, which would likely lift as they recover. On the other hand, if confabulating participants had slightly elated mood and poor insight into their difficulties to start with (see chapter 3 in this thesis), one might expect that as they recover from confabulation and gain insight into their condition, their mood might be increasingly depressed (Nahum et al., 2010). In the present investigation, confabulating participants' changes in depressed mood were charted over time, and the relative contribution of depressed mood in predicting changes in confabulation was examined.

In summary, TCC has been put forward as the only cognitive mechanism that parallels the course of confabulation. However the findings leading to this conclusion lack replication. Moreover the clinical course of confabulation has been relatively poorly studied. The few studies that explored this have not used large samples and have seldom taken mood or insight into consideration. However there is evidence that mood and insight may modulate confabulations. Therefore the aim of this study was to follow up confabulating patients in order to characterise the clinical course of confabulation along cognitive, insight and mood changes, and to explore the relative value of TCC, insight and mood in predicting the clinical course of confabulation. In particular the study aimed:

1. to explore changes over time in TCC performance in a group of confabulating participants;
2. to investigate changes over time in level of insight into memory difficulties and general well-being in confabulating participants;

3. to explore changes over time in elated and depressed mood in confabulating participants; and
4. to examine the relative contribution of initial TCC, insight, elated mood and depressed mood in predicting the clinical course of confabulation.

4.2. METHOD

4.2.1. Participants

In this study the same group of 24 confabulating participants described in previous chapters were followed up (see chapters 2 and 3 in this thesis). For the purpose of this study they were assessed on 3 occasions: 1) on inclusion to the study, 2) 3 months later and 3) 9 months after the initial assessment approximately.

Their characteristics have been described in the method chapter and will not be repeated here.

4.2.2. Background assessments

All participants underwent an initial comprehensive neuropsychological assessment on inclusion to the study. This was repeated 3 months later and again 9 months after the initial assessment. Background tests have been described in the method chapter and this information will not be reiterated here.

4.2.3. Experimental procedures

The same experimental measures used in a previous investigation were employed in this study (see chapter 3 in this thesis). As before, participants' confabulatory behaviour was measured with the Dalla Barba confabulation battery adapted for the UK (Dalla Barba, 1993a; Kopelman et al., 1997). Temporal context confusion (TCC) was measured using Schnider's continuous recognition task (Schnider et al., 2000a). The same measures of mood and insight described in previous chapters of this thesis were used for this study.

For the purpose of the current study the experimental procedures were carried out on inclusion to the study, and they were repeated 3 months later and again 9 months after the initial assessment.

4.2.4. Analyses

First the extent of recovery from confabulation was examined in the present sample over the 3 assessments. Two measures of confabulation were considered in turn: a) overall proportion of confabulatory answers to the Dalla Barba interview, and b) proportion of confabulatory answers to the episodic section of this interview. For each of these measures a trend analysis was carried out (i.e.: repeated measures one-way ANOVA linear contrast). Time of assessment (initial, 3-month, and 9-month follow-up) was the repeated measures variable, and either a) overall or b) episodic confabulations was the dependent factor.

Second, in order to characterise the clinical course of confabulation along changes in cognitive function, first background cognitive measures were examined (via inspection of means and SD) at two points in time: initial and final assessment. Substantial changes were explored further using repeated measures ANOVA and trend analyses (i.e. ANOVA linear contrasts).

Third, changes in experimental measures (TCC, insight, elated and depressed mood) across the 3 assessments were examined. For this trend analyses were carried out (i.e.: repeated measures one-way ANOVA linear contrast) with time of assessment as the repeated measures variable, and each experimental measure as the dependent factor. The Friedman test was employed when parametric assumptions were not met. As before, TCC was measured using the following formula: $(FP2/H2) - (FP1/H1)$ where: FP1 or FP2 = number of falsely recognised stimuli (false positives) in run 1 or 2, and H1 or H2 = number of correctly recognised items (hits) in run 1 or 2 ([Schnider et al., 2000a](#)).

Finally the relative contribution of experimental factors in predicting recovery from confabulation was investigated. Two potential measures of confabulation were used for this purpose: a) total number of confabulations across all sections of the Dalla Barba Confabulation Interview (overall confabulations maximum number= 80), and b) number of confabulations reported in the episodic memory subscale of the same interview (episodic confabulations maximum number= 15).

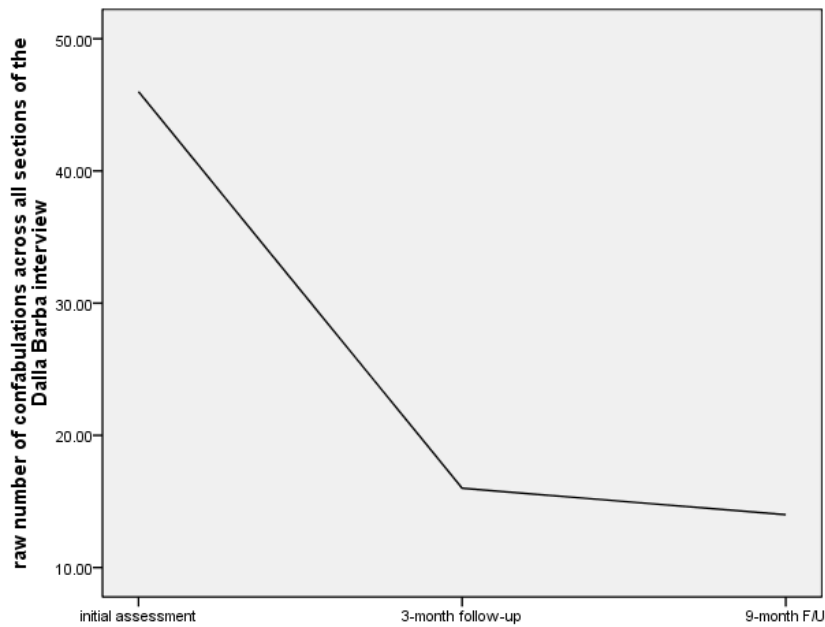
Prediction of change in *overall* number of confabulations

For this analysis as a first step, for each participant, a linear regression was carried out to calculate the slope of change in the number of confabulations reported across all sections of the Dalla Barba Confabulation Battery over the 3 assessments; the individual slopes were then saved as a separate variable in order to be used in the next analysis. The following example illustrates how this variable was obtained.

Figure 4.1 shows the raw number of confabulations produced by one of the participants over the 3 assessment sessions. In the first instance a linear regression was carried out using number of confabulations as the dependent variable and assessment session as the independent variable. Then the slope of the change in number of confabulations over time was extracted and used in the next step. The slope of this particular curve is $= -3.10$, as indicated by the B coefficient from this person's individual linear regression analysis.

The process followed above with 13js was repeated for all 24 confabulating patients. The slope of change in number of confabulations was recorded for each patient and then saved as a separate variable ready to be used in the next step. Next a linear regression was carried out with the slopes of change over time in overall number of confabulations as the dependent variable and initial scores on temporal context confusion (TCC), insight, elated and depressed mood, as the predicting variables. Backward stepwise selection was used to reduce the model to just those variables making an independent contribution to the prediction of change in confabulation.

Figure 4.1. Gradient of change on confabulation. Overall number of confabulations reported by 13js over the 3 assessment sessions at 0, 3 and 9 months respectively. The slope of this particular curve is = -3.10, as indicated by the B coefficient from this person's regression analysis.



Prediction of change in *episodic* confabulations

As in the previous analysis, first the gradient of change in number of confabulations was calculated for each person using a linear regression; except this time we used only the number of confabulations reported in the 'episodic' section of the Dalla Barba interview. Second the individual gradients (or B regression coefficients) were then saved as a separate variable in order to be used in the next analysis. Third a linear regression was carried out with gradient of change in episodic confabulation as the dependent variable and initial scores on TCC, insight, elated and depressed mood as the predicting variables. Backward stepwise selection was used to reduce the model to just those

variables making an independent contribution to the prediction of change in episodic confabulation.

4.3. RESULTS

4.3.1. Confabulation

The extent of recovery from confabulation was examined over the follow-up period. Two measures of confabulation were considered: a) overall proportion of confabulations and b) proportion of episodic confabulations. Table 4.1 shows the proportion of confabulations reported both across all sections of the Dalla Barba confabulation battery and in the episodic section specifically, over the 3 assessments.

Table 4.1. Confabulations over time. Means and standard deviations of proportion of confabulations reported by the experimental group over time on the Dalla Barba confabulation battery, as verified from informants and medical records

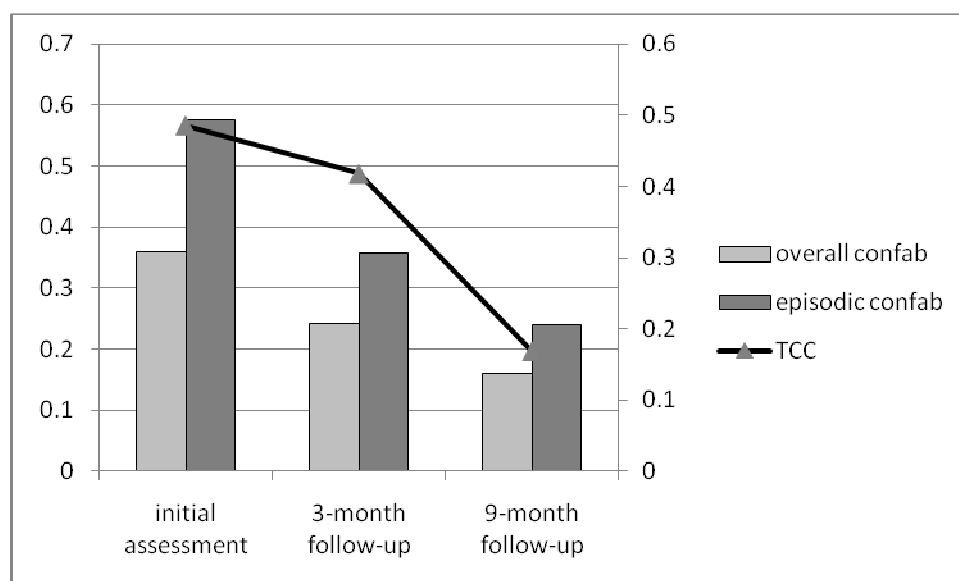
	Initial assessment			3-month follow-up			9-month follow-up		
	Mean	SD	N	Mean	SD	N	Mean	SD	N
<u>Overall</u>									
confabulations	0.360	0.105	24	0.243	0.121	24	0.161	0.110	23
<u>Episodic</u>									
confabulations	0.575	0.136	24	0.357	0.173	24	0.240	0.164	24

Overall proportion of confabulations

Between the first and the last assessment the mean proportion of confabulations reported across all sections of the Dalla Barba interview fell from

0.360 (SD 0.105) to 0.161 (SD 0.110). Parametric assumptions were met. Results of a repeated measures ANOVA showed a significant main effect of time on overall proportion of confabulations ($F(2,44)= 52.366, p<0.001$). A linear trend analysis was significant ($F(1,22)= 85.589, p<0.001$). This indicated that overall the proportion of confabulations reported decreased significantly over the 3 assessments, as shown in figure 4.2.

Figure 4.2. Clinical course of confabulation and TCC over time. 1. Left axis: Mean proportion of confabulatory answers reported on the Dalla Barba interview a) across all sections, or b) on the episodic section alone; and 2. Right axis: Mean TCC scores of 24 confabulating participants at 3 assessment times. Lower scores indicate better TCC performance



Episodic confabulations

Table 4.1 shows that from the first to the last assessment, the average proportion of confabulatory answers reported in the episodic memory section of the confabulation battery fell from 0.575 (SD 0.136) to 0.240 (SD 0.164).

Parametric assumptions were met. Results of a repeated measures ANOVA showed a significant main effect of time on episodic confabulations ($F(2,46)=39.856$, $p<0.001$). A linear trend analysis was significant ($F(1,23)=88.779$, $p<0.001$). This indicated that the proportion of episodic confabulations decreased significantly over the 3 assessments, as shown in figure 4.2.

4.3.2. Background measures

As previously described (see chapter 3 in this thesis), at the point of inclusion to the study, participants' brain injury had resulted in marked decline of general reasoning; this fell within the borderline between average and learning difficulties level of function. Participants also showed impaired memory (below the 5th percentile) and executive function (below the 10th percentile).

Tables 4.2 and 4.3 show very little change in most background measures between the first and last assessment. At the last follow-up, after approximately 9 months, participants had experienced at best moderate improvement in the following cognitive functions.

General reasoning, processing speed and executive functions

Table 4.2 shows that patients' mean general reasoning ability had improved from a previous borderline level of function ($\bar{x}=77.7$; SD 12.7) to a low average range ($\bar{x}=85.7$; SD 16.3) at the last assessment. There were mild improvements in speed of processing, although this still fell below the 10th

percentile. Table 4.3 shows that executive function remained largely unchanged, except for a very mild improvement in rule attainment ability (Brixton test); performance on this test improved from the 1st to the 5th percentile.

Table 4.2. Reasoning and speed of processing over time. Means, SD and percentiles of 24 confabulating participants on reasoning and processing speed measures obtained at initial assessment, 3-month, and 9-month follow-up.

Test	Initial assessment			3-month follow-up			9-month follow-up		
	Mean (SD)	%le	N	Mean (SD)	%le	N	Mean (SD)	%le	N
<u>Gral. reasoning</u>									
WASI current full scale IQ	77.7(12.7)	-	24	81.7(13.8)	-	23	85.7(16.3)	-	23
<u>Process. speed</u>									
SCOLP	22.8(10.64)	1-5	23	27.1 (12.6)	5	24	28.8(15.3)	5-10	24
WAIS-III - Digit Symbol	23.5(13.8)	1	24	27.3(18.1)	1	22	30.6(15.8)	2	24

Table 4.3. Executive function over time. Mean raw scores (SD) and percentiles of 24 confabulating patients on tests of executive function at initial assessment, 3-month, and 9-month follow-up.

Test	Initial assessment			3-month follow-up			9-month follow-up		
	Mean (SD)	%le	N	Mean (SD)	%le	N	Mean (SD)	%le	N
<u>Trail Making Test</u>									
- Part B	254.1(115.6)	10	23	237.3(166.9)	10	23	225.2(149.7)	10	24
<u>Cognitive Estimates Test</u>	14.2(5.5)	1	23	12.4(5.2)	1	22	11.3(5.1)	1	22
<u>Hayling Test</u>									
-Part A timing score	36.5(22.6)	5	24	26.6(20.2)	5	22	24.0(28.5)	5	23
-Part B timing score	81.4(47.5)	10	23	74.3(44.3)	10	22	77.8(49.2)	10	23
-Part C type a & b errors	40.7(23.6)	1	23	36.5(24.2)	1	22	32.8(20.5)	1	23
<u>Brixton Test</u>	31.1(10.8)	1	23	30.1(10.5)	1	22	24.2(7.4)	5	22

Memory

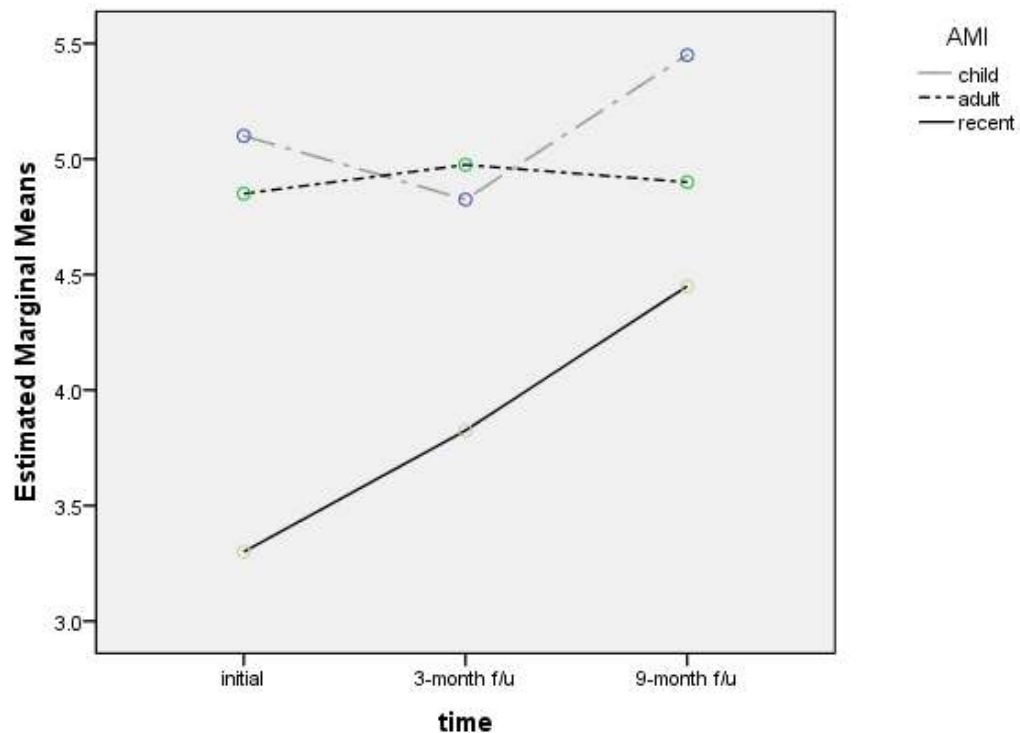
In terms of memory, minimal improvements were noted, but in general table 4.4 shows that anterograde memory function remained at or below the 5th percentile at the last follow-up. Areas of change included immediate verbal memory, which had improved from an initial 1st percentile to a final 2nd percentile. Delayed *verbal* memory also improved from an initial 1st percentile to the 5th at the last follow-up. Delayed *visual* memory had fallen within the 2nd percentile on initial assessment; at the last assessment this lay within the 5th percentile.

Figure 4.3 and table 4.4 show changes in autobiographical memory accuracy over time. Autobiographical memory for childhood events, which initially had fallen within the 'borderline abnormal' range, fell within the 'acceptable range' at the last follow-up. Memory for young adulthood remained virtually unchanged at the 'borderline' range. Memory for recent autobiographical events remained within the 'definitely abnormal' range, although mean scores on table 4.4 indicated larger changes than in the other two modalities of autobiographical memory. For this reason, and given that in a previous investigation significant differences had been observed between confabulating and non-confabulating participants on this measure (see chapter 3 in this thesis), changes in time were further investigated.

Table 4.4. Memory over time. Mean raw memory scores (SD) and percentiles of 24 confabulating participants at initial assessment, 3-month, and 9-month follow-up.

Test	Initial assessment			3-month follow-up			9-month follow-up		
	Mean (SD)	%le	N	Mean (SD)	%le	N	Mean (SD)	%le	N
<u>Anterograde memory</u>									
WMS-III – Immediate Logical Memory (LM)	12.3(8.2)	1	22	19.0(10.9)	2	21	18.6(10.9)	2	23
WMS-III – Delayed LM	3.1(4.3)	1	22	6.1(6.5)	2	21	7.0(7.9)	5	23
WMS-III – Recognition LM	18.6(3.6)	-	22	20.9(3.9)	-	21	20.6(4.5)	-	23
WMS-III - Immediate Visual Reproduction (VR)	41.0(16.7)	1	21	48.1(16.5)	1	21	47.7(22.7)	1	23
WMS-III - Delayed VR	6.8(8.9)	2	21	9.3(11.9)	5	21	13.7(14.8)	5	23
WMS-III - Recognition VR	34.6(4.0)	5	20	35.4(3.9)	5	21	35.5(3.4)	5	22
<u>Memory for emotional material</u>									
Cahill task - Emotional rating	6.3(3.0)	-	22	4.9(3.3)	-	21	5.0(3.6)	-	23
Cahill task - % remembered for the critical slide	34.8(25.7)	-	22	47.5(35.6)	-	20	60.3(29.6)	-	21
<u>Autobiographical Memory</u>									
AMI – episodic – childhood	5.0(0.5)	-	23	4.7(2.0)	-	24	5.5(2.1)	-	21
AMI – episodic – young adulthood	4.9(0.4)	-	23	5.1(2.1)	-	24	5.0(2.1)	-	21
AMI – episodic – recent events	3.0(0.5)	-	23	3.8(2.5)	-	24	4.4(3.2)	-	21

Figure 4.3. AMI over time. *Changes over time in mean accuracy scores of autobiographical memory for childhood, adulthood and recent events for 20 confabulating brain injured individuals.*



A repeated measures ANOVA with two within factors: AMI subtest (child, adult or recent) and time (initial assessment, 3-month follow-up or 9-month follow-up) was carried out. Mauchly's test indicated that the assumption of sphericity had been violated for the interaction term ($\chi^2(2)=28.51$, $p=0.001$), therefore degrees of freedom were corrected. Since $\epsilon < 0.75$, Greenhouse-Geisser estimates of sphericity were used for this correction ($\epsilon = 0.634$). A main effect of AMI subtest ($F(2,38)=5.998$, $p=0.005$) showed that participants had recalled some AMI subtests significantly more accurately than others. No significant effect of time indicated that no significant changes had taken place over the 3 assessments on this measure ($F(2,38)=1.112$, $p=0.339$). No significant interaction was found

between AMI subtest and time ($F(2.54,48.18)=1.568$, $p=0.214$). Planned pairwise comparisons indicated that AMI accuracy for child events was significantly higher than for recent events (mean difference=1.267, $p=0.015$). No other significant differences were found between AMI subtests (mean difference=0.217, $p>0.05$; mean difference=1.050, $p=0.099$).

In terms of memory for non-autobiographical material with high affective content, substantial differences had been found on the Cahill task between the experimental and control groups in a previous investigation (see chapter 3 in this thesis). Related to this, mean scores on table 4.5 show that at the last assessment, confabulating participants remembered approximately 50% more of the critical information on this task than they had recalled at the initial assessment.

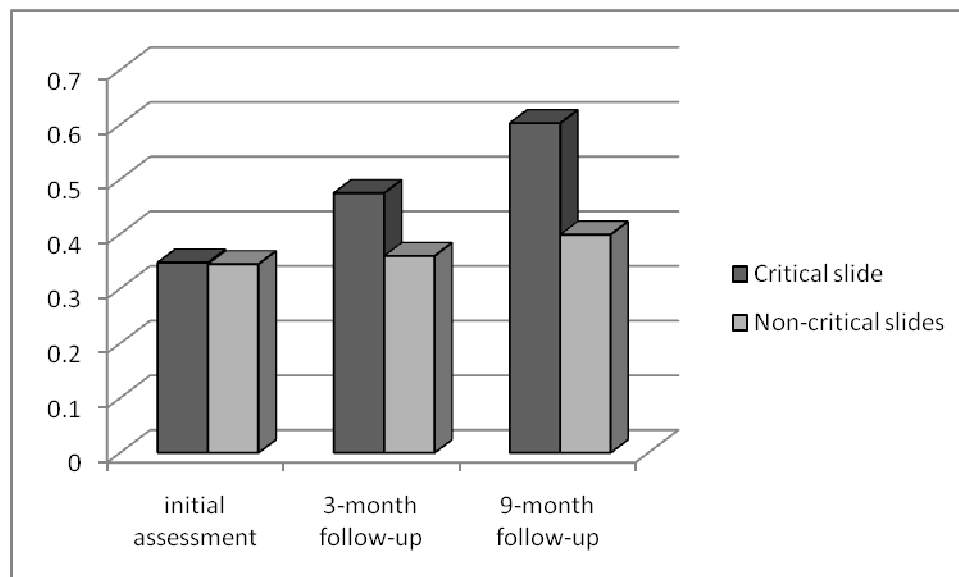
Table 4.5. Cahill Task over time. *Mean proportion of information correctly remembered by 22 confabulating brain injured participants on the Cahill task for (a) the critical slide, (b) the rest of the slides, and (c) the difference between critical and non-critical slides at initial assessment, 3-month, and 9-month follow-up.*

Cahill Task	Initial assessment			3-month follow-up			9-month follow-up		
	<i>Mean</i>	<i>SD</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>N</i>
Critical slide	0.348	0.257	22	0.475	0.356	20	0.603	0.296	21
Non-critical slides	0.345	0.146	22	0.360	0.147	20	0.399	0.159	21
Difference score	0.004	0.184	22	0.115	0.262	20	0.204	0.197	21

Changes over time in performance on this task were explored as follows. First, the mean proportion of information remembered from the non-critical slides (10 slides in total) was calculated at 3 points in time: (i) initial assessment, (ii) 3-month follow-up and at (iii) 9-month follow-up. Second, this mean was subtracted from the proportion of information remembered from the critical slide

at each assessment time. Third, a trend analysis was carried out with difference score as the dependent variable and time (initial, 3-month, and 9-month follow-up) as the within subjects factor. Figure 4.4 shows mean proportion of information correctly remembered by the confabulating group for the critical slide and the rest of the slides at initial assessment, 3-month, and 9-month follow-up.

Figure 4.4. Cahill task over time. *Mean proportion of information correctly remembered by 22 confabulating brain injured participants for the Cahill task's critical slide and the rest of the slides, at initial assessment, 3-month, and 9-month follow-up.*



Parametric assumptions were met. Repeated measures ANOVA showed a main effect of time on difference scores failed to reach significance ($F(2,32)=1.962$, $p=0.157$; but note that SPSS would only include $N=17$ in this analysis). However, due to the relatively large mean differences mentioned above and following statistical advice, trends in this data were examined. A linear trend analysis was significant ($F(1,16)= 5.224$, $p=0.036$). This indicated that difference scores increased with time. In other words, the advantage in

terms of the proportion of information remembered from the critical (highly emotional) slide –compared with the rest of the slides – increased with time, as shown in Figure 4.4.

4.3.3. Experimental measures

Table 4.6. shows that between the first and the last assessment the mean TCC score fell from 0.486 (SD 0.444) to 0.169 (SD 0.768). Figure 4.2 shows changes in TCC scores over the 3 assessments. Mauchly's test indicated that the assumption of sphericity had been violated ($\chi^2(2)=12.89$, $p=0.002$), therefore degrees of freedom were corrected using Greenhouse-Geisser estimates of sphericity ($\epsilon =0.686$). Results of a repeated measures ANOVA showed no significant main effect of time on TCC ($F(1.37,30.16)= 2.101$, $p=0.143$). As before, trend analyses were considered. A linear trend analysis showed that although TCC decreased with time, this trend was not statistically significant in this sample ($F(1,22)=3.368$, $p=0.080$).

Table 4.6. Experimental tasks over time. Means and standard deviations of 24 confabulating brain injured participants on experimental measures

	<i>Initial assessment</i>			<i>3-month follow-up</i>			<i>9-month follow-up</i>		
	<i>Mean</i>	<i>SD</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>N</i>
TCC	0.486	0.444	24	0.418	0.548	23	0.169	0.768	24
Insight	8.261	3.441	23	5.826	3.762	23	5.125	3.518	24
Elated mood	4.000	3.289	23	3.167	3.185	24	2.957	3.686	23
Depressed mood	3.435	2.842	23	4.304	5.112	23	2.833	2.988	24

Table 4.6 shows that mean self-reported insight scores improved from the initial assessment ($\bar{x}=8.3$; SD 3.4) to the last follow-up ($\bar{x}=5.1$; SD 3.5). The

sphericity assumption was met. Repeated measures ANOVA showed level of insight changed significantly over time ($F(2,42)=11.093$, $p<0.001$). A linear trend analysis was significant ($F(1,21)=18.707$, $p<0.001$). This indicated that insight scores decreased significantly over the follow-up period, as shown in Figure 4.5, representing an improvement in insight.

Figure 4.5. Experimental variables over time. *Changes in self-reported insight, elated and depressed mood mean scores over 3 assessment times for 24 confabulating brain injured individuals. Lower scores indicate less severe deficits in mood and insight.*

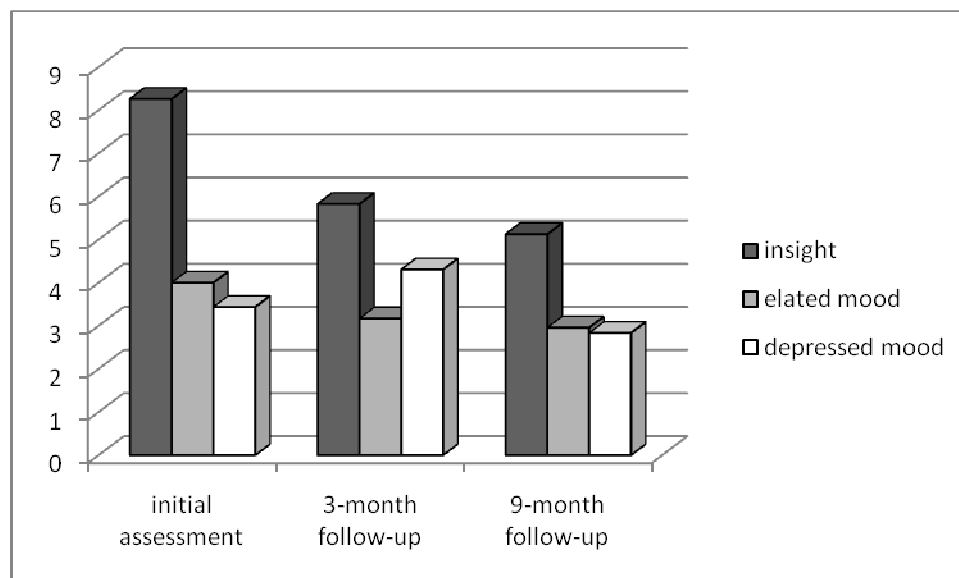


Fig 4.5 and table 4.6 also show that severity of self-reported levels of elated mood decreased over time from an initial mean score of $\bar{x}=4.0$ (SD 3.3) to $\bar{x}=3.0$ (SD 3.7) approximately 9 months later. Of note, these scores indicated that participants did not suffer clinically significant levels of elated mood, as they fell below the cut-off score (cut-off= 5). Distribution of initial scores was somewhat skewed. Therefore the Friedman test was carried out. Results showed that elated mood did not change significantly over time ($\chi^2(2)= 2.696$, $p=0.263$).

Figure 4.5 and table 4.6 show that self-reported levels of depressed mood also fell slightly between the first and the last assessment (\bar{x} =3.4(SD 2.8) to \bar{x} =2.8(SD 3.0) respectively). Of note, these scores indicated that participants did not suffer clinically significant levels of depressed mood, as they fell below the cut-off score (cut-off= 10). Distribution of initial scores was somewhat skewed. Therefore the Friedman test was carried out. Results showed that depressed mood did not change significantly over time ($\chi^2(2)=0.338$, $p=0.860$).

4.3.4. Predictors of confabulation recovery

The next analyses were used to investigate whether there were any predictors of recovery from confabulation among the experimental variables. Two measures of confabulation were used for this purpose: a) overall number of confabulations across all sections of the Dalla Barba Confabulation Interview (total confabulations), and b) number of confabulations reported in the episodic memory subscale of the same interview (episodic confabulations); the findings regarding each of these measures are reported in turn below.

Predictors of change in *overall* number of confabulations

As illustrated in the method section above, as a first step the slope of change in confabulation over the 3 assessments was calculated for each individual using linear regression. The slopes of change in confabulations for the 24 participants were recorded and saved as a separate variable, ready to be used in the next

step. The histogram of the resulting variable revealed a distribution consistent with a normal distribution of slopes in the population.

Next a linear regression was carried out with the slopes of change over time in overall number of confabulations as the dependent variable and initial scores on insight, TCC, elated and depressed mood scores as the predicting variables. Backward stepwise selection was used to reduce the model to just those variables making an independent contribution to the prediction of confabulation. No significant results were found. Using this statistical procedure, elated mood was the *last* predictor to be dropped ($p=0.143$). There was a positive but non-significant association between elated mood and change in overall number of confabulations in the current sample ($r_{xy}= 0.317$, $p= 0.070$, 1-tailed).

As the confabulating group was defined by exceeding a level of confabulation at baseline (as measured by the Dalla Barba confabulation interview score), regression to the mean on the independent factors was expected. This was accommodated by including the baseline measure (initial overall confabulation score) as an independent variable in the multivariable regression equation. In this way the effects of regression towards the mean could be separated from genuine effects due to the other independent factors (Bland and Altman, 1994). With this adjustment there was stronger evidence for an association between initial self-reported elated mood scores and gradient of change in overall number of confabulations (unstandardised coefficient $B = 0.107$; 95% confidence interval= $-0.003 - 0.217$; $p=0.056$).

Predictors of change in *episodic* confabulations

As in the previous section, for each person the gradient of change in confabulations was calculated; except this time only answers to the 'episodic' section of the confabulation interview were used. These gradients were saved as a separate variable ready for the next step. Their distribution was consistent with a normal distribution of gradients in the population.

Next a linear regression analysis was carried out with gradient of change in number of episodic confabulations as the dependent variable and initial scores on insight, TCC, elated and depressed mood scores as the potential predictors. No significant results were found. Similarly to the previous findings, there was a positive but non-significant association between elated mood and change in episodic confabulations ($r_{xy} = 0.317$, $p = 0.070$, 1-tailed) and elated mood was the last predictor to be dropped ($p = 0.141$).

As in the previous section, the confabulating group was defined by exceeding a level of confabulation at baseline (as measured by the Dalla Barba confabulation interview), thus regression to the mean was expected. This was accommodated by including the baseline measure (initial episodic confabulation score) as an independent variable in the multivariable regression equation. In this way the effects of regression towards the mean could be separated from genuine effects due to the other independent factors (Bland and Altman, 1994). With this adjustment there was stronger evidence for a statistically significant association between elated mood scores and gradient of change in number of

episodic confabulations (unstandardised coefficient $B = 0.033$; 95% CI = 0.002 – 0.065; $p=0.040$).

4.4. DISCUSSION

What predicts recovery from confabulation has been relatively understudied and is poorly understood. In this study potential predictors of changes in confabulation were investigated over time. For this purpose, 24 confabulating participants were followed up. They were interviewed on 3 occasions over the course of 9 months using the Dalla Barba confabulation battery ([Dalla Barba, 1993a](#)), the TCC task ([Schnider et al., 2000a](#)), and self-reported measures of insight into their difficulties and well-being, and of elated and depressed mood. In order to characterise the clinical course of confabulation, changes over time in TCC, insight and mood measures were explored. The relative value of initial scores on TCC, insight and mood measures in predicting changes observed on the confabulation interview was examined.

Regarding the first aim of the current investigation, improvements on performance on the TCC task were noted over the follow up period. However, they failed to reach statistical significance.

Regarding the second aim, results from this study showed that the proportion of confabulations reduced significantly and spontaneously over time in the present sample. At the same time participants' level of insight into their difficulties improved significantly.

Regarding the third aim of this study, a reduction of elated mood was noted over time, as expected. However, these changes failed to reach statistical significance. Depressed mood scores did not show a definite pattern of change. This may indicate that the effects of depressed mood on confabulation are likely to be very subtle at best ([Metcalf et al., 2010](#)).

Regarding the fourth aim, initial self-rated elated mood score was the best predictor of confabulation recovery. In particular, there was a significant association between elated mood scores and change in 'episodic' confabulations when regression to the mean was taken into account.

In addition, a significant trend, indicating improvement, was also found in performance on the Cahill task over time. Improvements in recent autobiographical memory were also noted, although they failed to reach significance. These findings are consistent with results from the previous investigation (chapter 3 in this thesis), indicating these two measures may be more sensitive than other background measures to the presence and clinical course of confabulation.

In summary the current investigations showed: (i) initial level of elated mood was the best predictor of changes in confabulation over time, and this association was stronger for episodic than for overall confabulations; (ii) self-reported level of insight showed significant improvement over time in line with the clinical course of confabulations; and (iii) performance on the TCC task showed a similar trend to the clinical course of confabulations (albeit not significant).

Very few longitudinal studies have examined the clinical course of confabulations. Virtually none has studied longitudinal changes within a large group of confabulators, nor have they taken mood and insight into account. In this study the relative value of TCC in predicting recovery from confabulation was investigated together with that of other potential predictors (insight, elated and depressed mood).

Current results would be partially consistent with findings that indicate that elated mood modulates memory in psychiatric populations. In these studies, elated mood was linked to a liberal bias in patients' responses to recognition memory tasks; this bias disappeared when patients recovered from the underlying mood disorder. Results from the previous investigation (see chapter 3 in this thesis) indicated that elated mood was a concurrent associate of the presence of confabulation and that it discriminated between confabulating and non-confabulating amnesic participants. Results from the present investigation extended these findings and showed that initial levels of elated mood predicted the slope of confabulation recovery; in addition they showed that elated mood decreased over time in line with recovery from confabulation. Taken together these findings would support explanations that propose that mood and emotional mechanisms may modulate the appearance and clinical course of confabulations (Conway, 2005; Fotopoulou, 2010; Metcalf et al., 2010; Gilboa, 2010). Whether mood affects the response bias of participants or whether it affects 'core' retrieval mechanisms, as has been suggested in the previous chapter of this thesis, is a question that may need to be addressed in future studies.

In addition, previous authors have seldom commented on recovery from confabulation ([Schnider, 2008](#); [Nahum et al., 2010](#)). Schnider has found that dopamine antagonists sometimes reduce confabulation ([Schnider, 2008](#)). Corwin et al. found that beta-blockers reversed elated mood disorders and an associated excessive willingness to guess during memory recognition ([Corwin et al., 1990](#)). However, if the present findings were replicated, they may have clinical implications. For example it is possible that reducing initial levels of elated mood may accelerate the rate of recovery from confabulation.

Other treatments that have successfully reduced confabulations have included awareness and self monitoring training, although authors failed to explain why they worked ([DeLuca, 2009](#); [Dayus and Van, 2000](#)). In the current sample insight into difficulties improved significantly over the follow-up period in line with confabulation recovery. This result is consistent with clinical observations indicating that recovery from confabulation was accompanied by improved insight ([Feinberg and Roane, 1997](#); [Mercer et al., 1977](#)). These authors have described confabulation as “an alteration in identity or in relatedness to the environment.” ([Feinberg and Roane, 1997](#)).

Related to this, absence of enhanced retrieval for non-personal affective information (as measured by the Cahill task) has been attributed to lack of appropriate “experiencing” of emotion in external stimuli ([Tranel et al., 2006](#); [Adolphs et al., 1997](#)). In a previous investigation it was found that this enhanced effect of affective material on memory was absent in the current group of confabulating participants, in contrast with non-confabulating amnesic

participants (see chapter 3 in this thesis). Current results indicated this effect returned over time in line with a reduction in confabulation.

One possible explanation for these results would be that confabulation is accompanied by a disconnection from the external world, and as confabulation reduces, patients are better able to 'relate' to their environment ([Feinberg and Roane, 1997](#)). Another possible explanation for the present findings would be that confabulation is caused by deficits experiencing ongoing reality, and as these lift, patients recover from confabulation ([Schnider, 2008](#); [Dalla Barba and Boisse, 2010](#)). A third explanation would be that awareness develops as the individual is better able to detect conflict between what are experienced as 'vivid' memories against their implausibility ([Johnson, 1991](#)). A further explanation for these results would be that confabulation is accompanied by dysfunction in an attentional gateway (Burgess et al., 2007a). In the case of confabulators, this would result in disproportionate representation of internally generated thoughts without enough reference to external events. Once function in this attentional gateway is recovered, the individual would be able to switch attention between internally and externally generated information as required. This in turn would allow for appropriate verification of memories. In any case it is clear from the present findings that further study is required in order to determine the specific role that insight and mood play in the appearance and clinical course of confabulation.

Finally, Schnider et al. have argued that TCC is a critical factor in the appearance of and recovery from spontaneous confabulation. Results from the

present study lend partial support to Schnider's hypothesis. Improvements in TCC over time were indeed consistent with improvements in confabulation.

However this trend just missed statistical significance in the present sample. Indeed, Schnider (2008, pg. 251) himself has described individual cases where TCC did not parallel confabulation recovery. Critics of Schnider's hypotheses have proposed that TCC may be sensitive to confabulation, but it is not specific to this condition; for example TCC failed to discriminate between confabulating patients and non-confabulating patients who had suffered an anterior communicating artery aneurysm (Gilboa et al., 2006). Gilboa (2010) concluded that TCC may be necessary but it is not sufficient for the appearance of confabulation. Similarly the present results suggest that TCC may have played a part in the recovery from confabulation for some patients, but it was not critical for confabulation recovery in the present sample.

In conclusion the present results indicated that elated mood at the onset was the best predictor of recovery from confabulation. This association was strongest for episodic confabulations. Significant improvements in levels of insight occurred in line with improvements in confabulatory behaviour. The present findings indicate mood and insight may play a role in the recovery of confabulation which has not been reported previously.

Chapter 5

Study 3 - Affective valence of confabulations

5.1. INTRODUCTION

Previous investigations have indicated that insight and affect may play a role in the appearance and clinical course of confabulations. The present study aimed to explore affective biases in the content of confabulations themselves, compared with true memories. Several reviews of theoretical models of confabulation have recently been published ([DeLuca, 2009](#); [Fotopoulou, 2009](#); [Kopelman, 2010](#); [Schnider, 2008](#)). Of particular relevance to the present investigation are explanations which place an emphasis on the contributions of personal identity and personal biases in the formation of confabulations.

Although there is evidence linking confabulations to pathology in specific regions of the brain (namely, the ventro-medial and orbito-frontal cortex) and to particular memory and executive deficits (e.g. [Gilboa et al., 2006](#); [Schnider, 2003](#); [Toosy et al., 2008](#); [Turner et al., 2008a](#)), it remains unclear how the contents of confabulations are generated. Several authors have pointed to the role of self-identity and emotion in the formation of confabulations ([Burgess and McNeil, 1999](#); [Conway and Pleydell-Pearce, 2000](#); [Johnson and Raye, 2000](#); [Kopelman, 1999](#)). Autobiographical memories have been described as a relatively faithful reconstruction of the past in the light of present goals and self-images; memories are not generated in a vacuum ([Conway and Pleydell-](#)

[Pearce, 2000; Fotopoulou, 2008](#)). The sense of personal identity relies on autobiographical memories, and these memories are constructed to reflect not only our past experiences, but also our notion of 'self' and any particular goals and emotions prevailing at the time of reconstruction ([Conway and Pleydell-Pearce, 2000; Conway and Tacchi, 1996; Fotopoulou et al., 2007a](#)).

One hypothesis is that confabulations arise as an exaggeration of the personal biases that affect healthy memory processes ([Conway & Tacchi, 1996; Fotopoulou et al., 2004; Fotopoulou et al., 2007a; Turnbull et al, 2004a](#)). In the absence of specific retrieval cues, 'generic representations' consistent with personal wishes and goals are created ([Burgess and McNeil, 1999; Metcalf et al., 2010](#)). The concept of 'self' is one of the most salient and robust schema we hold; therefore, false autobiographical memories are likely to command an exaggerated sense of confidence in their veracity ([Gilboa et al., 2006; compare Dalla Barba et al., 1997](#)). Faulty monitoring mechanisms may lead to the confident acceptance of such biased memories as correct ([Burgess and Shallice, 1996; Gilboa et al., 2006](#)).

Some authors have argued that personal biases in confabulation are not only self-referent but also self-serving ([Fotopoulou et al., 2007b](#)). Human beings have a natural tendency to present themselves in a pleasant light and, in the context of deficits in memory retrieval, motivational aspects play an increased role in determining memory recollection ([Turnbull et al., 2004b; Walker et al., 2003](#)). The role of such motivational forces is two-fold: (i) they provide a sense of self-coherence (i.e.: consistency with the pre-injury self-image and reality);

and (ii) they facilitate a feeling of self-enhancement (i.e.: presenting oneself in a more pleasant light) (Fotopoulou, 2008, 2009).

In a series of well-controlled experiments, Fotopoulou (2010) has found that independent raters consistently judged confabulations to be more pleasant than the 'real' facts the confabulations had replaced (see Fotopoulou, 2010, for a review). Confabulating patients produced significantly more pleasant false memories than did healthy controls (Fotopoulou et al., 2004, 2008b); and the patients' false memories were judged significantly more pleasant than were their true memories (Fotopoulou et al., 2007a , 2008b). On the basis of such evidence, Turnbull et al. (2004a) and Fotopoulou et al. (2008b) have both argued that confabulations may provide a self-preserving function against a patient's awareness of his/her adverse circumstances (Fotopoulou, 2008; Turnbull et al., 2004a). Consistent with this, some studies have found that (pleasant) confabulations are associated with low mood, a topic which requires further study (Fotopoulou, 2008; Fotopoulou et al., 2008b; Turnbull et al., 2004a).

More recently Metcalf et al. (2010) reported that this self-enhancing bias is not universal, because they found that it was present only in *some* confabulations; these were mainly confabulations relating to the most recent (postmorbid) time-period, rather than earlier (premorbid) time-periods. Korsakoff himself had reported unpleasant confabulations, noting that funerals and deaths were common themes in his patients' confabulations (cited in Schnider, 2008). Moreover, Metcalf et al. (2010) raised the possibility of a mood-congruent bias in the emotional content of confabulations; they found evidence of depression in

those patients with the least positive bias in their confabulations. Several authors have found a high proportion of neutral (or 'realistic') confabulations in their patients ([Dalla Barba and Boisse, 2010](#); [Metcalf et al, 2010](#)). Metcalf et al (2010) argued that the content of confabulations primarily reflects the tendency to retrieve generic memories when memory retrieval is faulty (compare [Dalla Barba et al, 1997](#); [Gilboa et al, 2006](#)). However, Metcalf et al. (2010) also acknowledged that there can be a personal bias towards those memories (pleasant or unpleasant) which are consistent with the patient's premorbid self-image in an attempt to preserve a coherent self-identity in the face of changing reality.

In summary, there is disagreement regarding the underlying basis of confabulation and, in particular, whether and to what extent emotional mechanisms determine the content of confabulations. However, many of the theoretical arguments have been postulated on the basis of well-controlled single case-studies or from small case-series, and there have been relatively few large group studies of confabulation to date ([Fotopoulou et al., 2008a](#); [Turner et al., 2008a](#)). In the present investigation, a relatively large group of confabulating patients have been examined to look for affective bias in confabulations. The aims of the present study were as follows:

1. to investigate whether participants showed an enhanced proportion of pleasant content in their confabulations relative to the 'real' information they had replaced;
2. to determine whether participants' confabulations were rated as having higher levels of affective content, rather than neutral content, compared with their 'true' memories;

3. to investigate whether those confabulations containing affective content/material showed an enhanced proportion of pleasant content, as opposed to unpleasant content, compared with their true memories;
4. to examine whether there was a correlation between each participant's current mood state and the mean valence score of his/her confabulations and/or true memories; and
5. to investigate whether there was any difference in the pattern of performance between those patients who had focal pathology in the ventro-medial or orbito-frontal cortex and those who did not.

5.2. METHOD

5.2.1. Participants

24 patients were included in this investigation: all 24 manifested confabulation according to their medical records, at an initial assessment interview with A.B., and on Dalla Barba's (1993a) Confabulation Battery.

As described before, the cases were recruited because of the presence of 'spontaneous' confabulation, rather than on the basis of a particular underlying aetiology (compare Dalla Barba & Boissé, 2010; Metcalf et al., 2010). Of the 24 patients, 20 (83.3%) had been recorded as having acted upon their confabulations. For example, one patient (a school teacher) patrolled the corridors of the hospital at night believing he was inspecting the dormitories at a boarding school. Another patient, believing that he was still living at home rather

than in hospital, travelled 30 miles to his home on public transport (hitching a lift, and then taking two trains) despite not having any money.

Clinical MRI or CT scans were obtained for 21 of our 24 participants. The scans showed that 10 participants had sustained focal lesions that involved the orbito-frontal and/or ventro-medial prefrontal cortex (VMFC); 3 had focal pathology that did not involve the VMFC; and 8 had suffered some degree of generalised atrophy.

5.2.2. Background assessments

All the participants underwent background neuropsychological assessment as described in previous investigations (for details please see chapters 2-4 in this thesis).

5.2.3. Experimental Procedures

Patients were administered the personal semantic and the episodic memory sections of the Dalla Barba ([1993a](#)) confabulation interview, modified for use in the UK ([Kopelman et al., 1997](#)). They were also administered the childhood, young adult, and recent items from the autobiographical incidents ('episodic') schedule of the Autobiographical Memory Interview ([Kopelman et al., 1990](#)).

Patients' responses on both these interviews were transcribed verbatim. Their relatives (usually the wife, husband, or partner) were then interviewed, and their

medical records were examined in order to determine the accuracy of their responses, and to identify which responses had been confabulated.

Two methods have been employed to judge emotional valence of memories: the 'comparison' method and the 'face value' method. In the 'comparison' method, pleasantness/unpleasantness ratings are made relative to the 'reality' of an event, where a memory has been confabulated (Fotopoulou et al., 2004, 2008b). The 'comparison' method was employed to investigate whether the confabulations obtained represented a specific improvement on the patient's current or 'real' situation (Fotopoulou et al., 2004, 2008b). An advantage of this method is in evaluating the affective load of memories against their actual reality. A putative drawback of this method is that this 'comparison' evaluation can be applied only to confabulations. Consequently, in the current study, the 'face value' method was also used; this allowed for direct comparisons between confabulations and 'true memories'. In this method, raters are asked to evaluate memories on a 1 to 7 point scale for their (face value) pleasantness/unpleasantness (Metcalf, 2006).

'Comparison' method

For this analysis within the patients' transcriptions the confabulated responses were indicated in boldface; the confabulated utterances were accompanied by a parenthesised statement in italics indicating the 'real' facts which the confabulations had replaced. Two raters (judges, 1 male, 1 female) were asked to evaluate these transcripts for pleasantness/unpleasantness.

The judges were told that the patients had recently suffered a severe brain disease or injury, and that the interviews had been carried out while they were in hospital. The raters were asked to score each 'memory' or statement in terms of its pleasantness on a scale of 1 to 7 (where 7 represented the most pleasant, 4 neutral/could not decide, and 1 the most unpleasant memories). Only ratings made for the confabulated 'memories' were included in this first analysis. Where a memory was indicated by boldface to be a confabulation, the judges/raters were asked to give their pleasantness/unpleasantness judgement *relative to* the 'real' information they had replaced, indicated on the transcript in parenthesised italics (compare Fotopoulou et al., 2004). The confabulated segments typically consisted of 1 to 3 brief sentences, and the parenthesised italics (the 'true' information) were of similar length.

The mean of the two ratings was calculated for each item, and the resulting scores were coded. For this purpose, ratings above 4 were categorised as 'pleasant'; ratings of 4 were considered neutral; and ratings below 4 were classified as 'unpleasant'.

For example the following statement received a mean rating of 6.5 (i.e. pleasant): asked what he did for his birthday, one of the participants replied: "I went out to dinner with my wife." (*In reality he spent the day in hospital*). The following statement received a mean rating of 2.5 (i.e. unpleasant): asked if he remembered the day he was admitted to hospital, a participant replied: "Everything was in chaos because a patient had 'A.W.O.L.', and most things weren't working" (*In reality this was an ordinary quiet day on the ward*).

The current study's first aim was to investigate whether patients showed an enhanced proportion of pleasant content within their confabulations when these were rated relative to the 'real' information they had replaced ('comparison' ratings). For this first the following calculations were carried out: a) the percentage of confabulations with pleasant content was calculated using the formula: $[100 * (\text{pleasant confabulations}) / \text{number of confabulations}]$; b) the percentage of confabulations with neutral content was calculated with the formula: $[100 * (\text{neutral confabulations}) / \text{number of confabulations}]$; and c) the percentage of confabulations with unpleasant content was calculated using the formula: $[100 * (\text{unpleasant confabulations}) / \text{number of confabulations}]$. Second, in order to test the significance of differences between these proportions a repeated measures one-way ANOVA was carried out, with emotional valence (positive, neutral or negative) as the independent factor and proportion of confabulations as the dependent variable; this was followed by associated post-hoc tests for multiple comparisons.

The 'face value' method

Two naive raters (2 female psychology undergraduates) were presented with the same transcripts of participants' responses to the Dalla Barba and AMI interviews, containing a) items to which the participant had responded with a true memory and b) confabulated responses (according to the interview with the wife, husband or partner) as in the 'comparison' method, except that this time the transcripts did not contain the 'real' information which the confabulations had replaced. The raters were not told whether a response was true or false; they were given the following instructions: *"Please rate the response to each of*

the enclosed interview questions according to how pleasant or unpleasant you think the answer is. Please use the scale 1 -7, where 1 is very unpleasant (or negative) and 7 is very pleasant (or positive)." (Metcalf, 2006).

The raters were given example ratings, taken from Metcalf (2006):

- i) *"very pleasant (i.e. rating 7) "The day my daughter was born was the happiest day of my life. Just looking at her face for the first time brought tears of happiness to my eyes";*
- ii) *neutral (i.e. rating 4) "My daughter is 6 years old";*
- iii) *very unpleasant (i.e. rating 1) "I backed out of my driveway and I ran over my cat in front of my wife. We were both very upset and I was so angry at myself for not looking where I was going".*

As before, the mean of the two judges' ratings was calculated for each item, and the scores were coded. For this purpose, ratings above 4 were categorised as 'pleasant'; ratings of 4 were considered neutral; and ratings below 4 were classified as 'unpleasant'.

The second aim of this study was to examine whether patients showed a bias to report confabulations with affective (rather than neutral) content, compared with their true memories. For this first the percentage of confabulations with affective content was calculated using the formula: $[100 * (\text{pleasant} + \text{unpleasant confabulations}) / (\text{pleasant} + \text{unpleasant} + \text{neutral confabulations})]$, and for true memories the formula used was: $[100 * (\text{pleasant} + \text{unpleasant true memories}) / (\text{pleasant} + \text{unpleasant} + \text{neutral true memories})]$. In order to test the significance of differences between these proportions, a paired t-test was used.

The third aim was to investigate whether patients showed an enhanced proportion of pleasant content within their 'affective' confabulations (i.e. confabulations with a score > or < than 4), compared with the proportion of pleasant memories among their 'affective' true memories. For this analysis only memories that had an emotional load - either pleasant or unpleasant - were included. The percentage of confabulations with pleasant content was calculated using the formula: $[100 \times \text{pleasant confabulations} / (\text{pleasant} + \text{unpleasant confabulations})]$, and for true memories the following formula was used: $[100 \times \text{pleasant true memories} / (\text{pleasant} + \text{unpleasant true memories})]$. These proportions were then compared using a paired t-test.

The fourth aim of this investigation was to examine whether there was a correlation between each participant's current mood state and the mean valence score of his/her confabulations and/or true memories. In order to investigate this, correlations between the mean pleasantness ratings and self-ratings on a mood (depression) scale were examined ([Zigmond and Snaith, 1983](#)).

Finally the issue of whether patients with pathology involving the ventro-medial or orbito-frontal cortex (collectively labelled VMFC) differed from patients without obvious VMFC pathology in terms of affective content in confabulations was investigated. MRI or CT scan films and reports were available for 21 patients; these were examined and classified in terms of: (i) focal damage affecting the VMFC (10 patients); (ii) focal damage not extending to the VMFC (3); or (iii) some degree of generalised atrophy only (8). Because the second

group consisted of only 3 patients, and the study focused on the effects of the VMFC on affective ratings, the last two groups were merged into one. The following two groups were then compared: those with focal VMFC (N=10) and those without focal VMFC pathology (N=11), looking at the percentage of affective memories among the confabulations and true memories in each lesion group. For this analysis each participant's percentage of affective memories among his/her confabulations and true memories was calculated using the same formulae as in the second analysis (i.e. the percentage of affective memories in each patient's confabulations, and the percentage of affective memories among each person's true memories). A repeated measures ANOVA was then carried out with lesion site (focal VMFC, other pathology) as the independent (between) factor, memory type (confabulation or true memory) as the within factor, and percentage of affective memories as the dependent variable.

5.3. RESULTS

5.3.1. Background cognitive testing

Table 3.1 (in chapter 3 in this thesis) shows background neuropsychological test scores.

Table 5.1 shows the mean percentage of items to which participants gave confabulatory responses on the episodic and personal semantic sections of the Dalla Barba confabulation battery used in this investigation. On this scale, the patients gave confabulatory answers to a mean of 57% (SD 15) of items from

the episodic section and 36% (SD 13) from the personal semantic section. On the AMI, the patients gave confabulations to between 36% and 64% of the items across the different time-periods (overall mean 52.7%) with more confabulations on the 'recent' than the 'childhood' items. Table 3.1 in chapter 3 of this thesis shows the accuracy and quality of the memories produced on the AMI, scored as in the original Manual (Kopelman et al., 1990). The patients' mean scores on the 'childhood' and on the 'young adulthood' items from the AMI fell within the 'borderline abnormal' level of recall. The patients' mean scores on the 'recent' items fell within the 'definitely abnormal' range. As mentioned before, this pattern is consistent with a temporal (or Ribot) gradient (Kopelman et al., 1990).

Table 5.1. Confabulations. *Dalla Barba¹ and AMI² mean percentage of confabulations, as verified from informants and the medical records*

Test	N	Mean	SD
Dalla Barba – episodic interview % confabulations	24	57%	15
Dalla Barba – personal semantic % confabulations	24	36%	13
AMI - episodic – childhood % confabulations	24	36%	33
AMI - episodic – young adulthood % confabulations	24	58%	28
AMI - episodic – recent events % confabulations	24	64%	34

¹(Dalla Barba, 1993a) adapted for UK (Kopelman et al., 1997)

²(Kopelman et al., 1990)

5.3.2. Confabulations

Across the Dalla Barba battery and the AMI, 24 participants gave a total of 1056 responses. Of these, 481 were 'true' memories, 83 were 'don't know' or 'can't remember' responses, and 492 were confabulations. The 'don't know' and 'can't remember' responses were eliminated from any further analysis. This left 973 'memories' for analysis.

5.3.3. Inter-rater reliability

'Comparison' ratings for confabulations

The inter-rater reliability between the two judges' 'comparison' ratings for pleasant/neutral/unpleasant content across the 492 confabulations was kappa = 0.499 ($p < 0.001$). This is classified as 'moderate' according to Landis & Koch (1977).

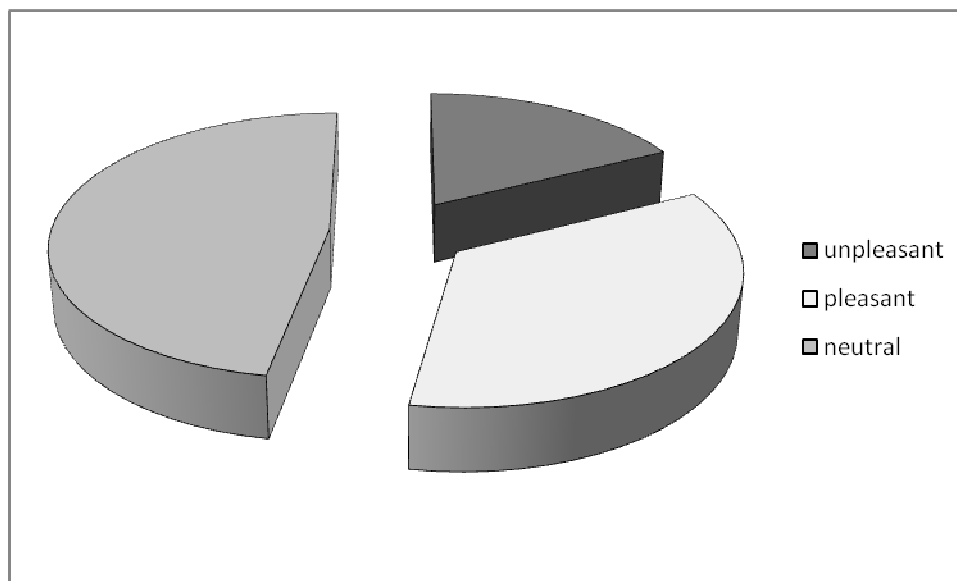
'Face value' ratings for confabulated and 'true' memories

The inter-rater reliability between the two judges' 'face value' ratings for pleasant/neutral/unpleasant content across the 973 'memories' was kappa = 0.609 ($p < 0.001$). This is classified as 'substantial' according to Landis & Koch (1977).

5.3.4. Emotional content of confabulations rated using the 'comparison' method

Figure 5.1 shows the mean percent of confabulations evaluated as 'pleasant' (>4), 'neutral' (=4) or 'unpleasant' (<4) using the 'comparison' method (Metcalf et al., 2010). Figure 5.1 shows that overall the majority of participants' confabulations attracted a neutral rating (i.e.: neither more pleasant nor more unpleasant than the 'real' facts they replaced), followed by pleasant and lastly unpleasant ratings.

Figure. 5.1. 'Comparison' ratings. *Mean percent of confabulations rated using the 'comparison' method as 'unpleasant', 'pleasant', or 'neutral' by two judges on data from 24 confabulating memory-disordered patients.*



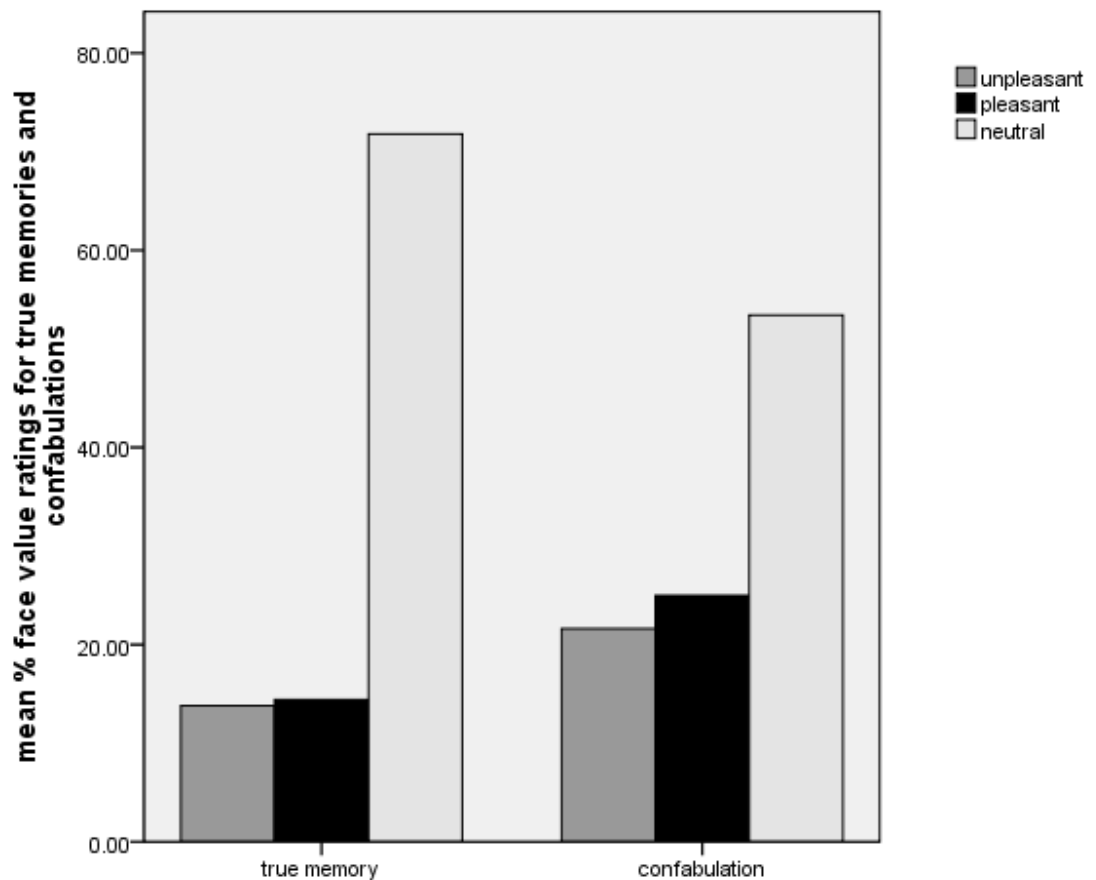
The first aim of this study was to examine whether patients showed a bias to report pleasant content in their confabulations relative to the 'real' information the false memories have replaced. Parametric assumptions were met. One-way ANOVA repeated measures with emotional valence (pleasant, neutral or

unpleasant) as the independent factor and percentage of confabulations as the dependent variable showed there was a significant difference between valence ratings given to confabulations using the comparison method ($F(2,46)=16.850$, $p<0.001$). Bonferroni-adjusted pairwise comparisons showed a significant minority of confabulations were evaluated as unpleasant, compared with those given either neutral or positive ratings (\bar{x} difference= 29.7, $p<0.001$; and \bar{x} difference= 17.5, $p=0.007$ respectively. No significant differences were found between proportions of pleasant and neutral ratings (\bar{x} difference= 12.1, $p=0.158$). In other words, the majority of confabulations examined in the current study were rated as being either neutral or pleasant when using the 'comparison' method.

5.3.5. Affective content of confabulations versus true memories

'Face value ratings' were used for all remaining analyses in order to compare confabulated and 'true' memories. Figure 5.2 shows the mean percent of memories evaluated as 'pleasant' (>4), 'neutral' ($=4$) or 'unpleasant' (<4) separately for the 'true' memories and the confabulations. Figure 5.2 shows that overall the majority of participants' memories attracted a neutral rating, followed by pleasant and lastly unpleasant ratings, irrespective of whether the memories were true or false

Figure. 5.2. 'Face value' ratings. Mean percent of memories rated at 'face value' as 'unpleasant', 'pleasant', or 'neutral' among the 'true' and confabulated memories by two judges on data from 24 confabulating brain injured memory-disordered patients.



The second aim of this study was to investigate whether patients showed a bias to report affective (rather than neutral) content in confabulations, but not in true memories. For this analysis the percentage of affective confabulations (pleasant or unpleasant) was compared with that of true memories. All memories were included in this analysis (percentages of affective memories were calculated in relation to the number of neutral memories, as indicated by the formula shown in page 158 of this thesis). The mean percent of *confabulations* with affective content was 46.6 (SD 14.8) and the mean percent of *true memories* with affective content was 28.2 (SD 13.4). The variables were normally distributed. A paired t-test analysis indicated confabulations contained a significantly higher

percentage of statements with affective content than true memories ($t(23)=5.195$, $p<0.001$, 2-tailed).

The third aim was to investigate whether patients showed an enhanced proportion of pleasant content in their confabulations, compared with their true memories. For this analysis only confabulations with affective content were selected, and the percentage of these which had pleasant content ($\bar{x} = 54.1$; SD 22.5) was calculated; this procedure was repeated for true memories ($\bar{x} = 47.7$; SD 26.9). The variables were normally distributed. A paired t-test indicated there was no significant difference between the percentage of pleasant content among the 'affective' confabulations compared with the percentage of pleasant content among the 'affective' true memories ($t(23)= 0.890$, $p= 0.383$, 2-tailed).

5.3.6. Correlations between affective valence of memories and participants' mood-state

The fourth aim of this study was to see whether there was a correlation between each participant's current mood state (as self-reported on the HADS scale for depression) and the mean valence score of his/her confabulations. For this analysis, the mean valence of confabulations and the mean valence of true memories were calculated, respectively, for each patient. These were then correlated with each patient's HADS-depression score. As the variables were not normally distributed, non-parametric correlations were calculated using Kendall's tau. There was a weak negative correlation between the valences of both types of memories and depressed mood scores (Kendall= -0.277, $p= 0.074$, and Kendall= -0.270, $p= 0.083$, 2-tailed respectively) i.e.: unpleasant

content was weakly associated with depressed mood in both confabulated *and* true memories.

5.3.7. Comparison between lesion groups

Figure 5.3a&b shows the percent of confabulations and 'true' memories evaluated as 'pleasant' (>4), 'neutral' ($=4$) or 'unpleasant' (<4) for patients with focal VMFC involvement (Fig. 5.3a) and for patients with either generalized atrophy or focal lesions not involving the VMFC (Fig. 5.3b). Figure 5.3a&b would suggest that participants with focal VMFC pathology reported comparatively more pleasant confabulations than those without focal VMFC involvement. A repeated measures ANOVA was carried out with, lesion site as the independent (between) factor (VMF, other pathology), one within factor, which was memory type (confabulations or true memories), and the percentage of affective memories as the dependent variable. Parametric assumptions were met. The effect of lesion was not statistically significant ($F(1,19)= 2.533$, $p=0.128$), and, more particularly, there was no significant interaction between lesion site and memory type ($F(1,19)= 0.450$, $p=0.510$). In brief, there was no evidence of lesion type affecting the percentage of emotionally charged memories between confabulations and true memories.

Figure 5.3a&b. ‘face value’ ratings according to pathology. *Mean percent of memories rated at ‘face value’ as ‘unpleasant’, ‘pleasant’, or ‘neutral’ among the ‘true’ and confabulated memories by two judges on data from 21 confabulating memory-disordered patients: (a) those whose focal pathology involved the VMFC (N= 10); and (b) those with different pathologies: either generalized atrophy or focal lesions not involving the VMFC (N= 11).*

Figure 5.3a. VMFC

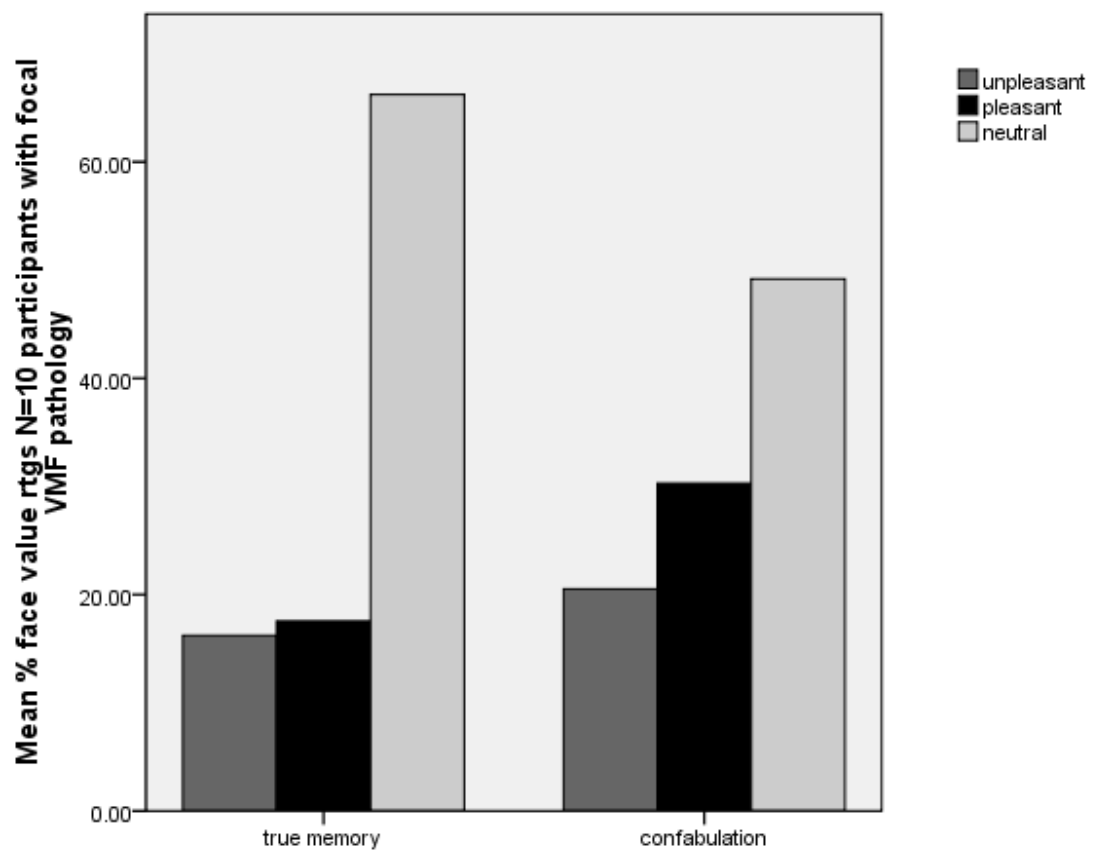
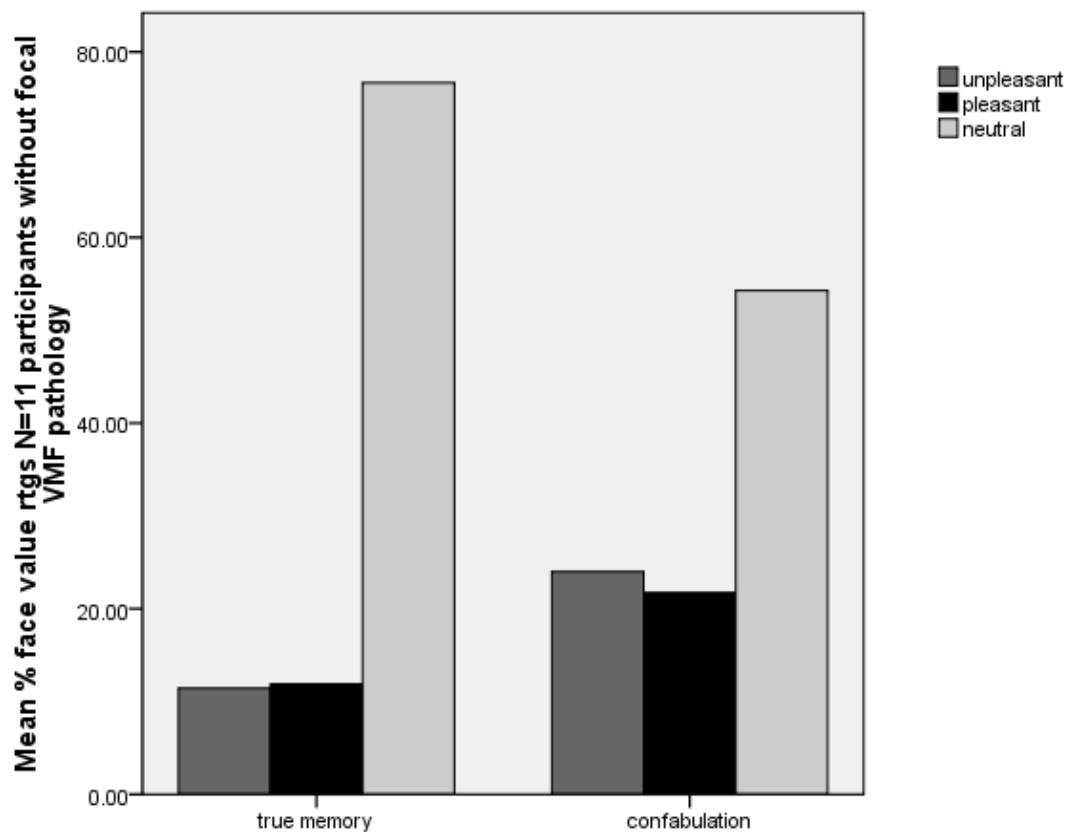


Figure 5.3b. Non-VMFC



5.4. DISCUSSION

The nature of confabulation remains a matter of much debate. In particular, the question of whether there is a motivational bias in confabulation, such that confabulations tend to be pleasant and self-enhancing (relative to 'real' or 'true' memories), remains controversial. In this investigation, 24 patients who had been spontaneously confabulating, 20 of whom had acted upon their confabulations, were studied. Their responses to the 'episodic' and personal semantic sections of the Dalla Barba Confabulation Battery, and to the incidents/episodic schedule of the Autobiographical Memory Interview (AMI)

were examined. Two methods were used to evaluate the affective content of memories. The 'comparison' method was used to investigate affective biases of confabulations compared with the 'real' facts they had replaced. The 'face value' method was used to evaluate the affective content of confabulations compared with 'true' memories.

Regarding the first aim of this study, participants showed an enhanced proportion of pleasant content in their confabulations when the 'comparison' method was used to rate them.

Regarding the second aim, an enhanced proportion of affective content (irrespective of whether it was pleasant or unpleasant) was found in confabulations, but not in 'true' memories when the 'face value' method was used.

Regarding the third aim, among the memories with affective content, similar proportions of pleasant and unpleasant content were found in both confabulated and 'true' memories.

Regarding the fourth aim, unpleasant content in all memories (true and false) was weakly correlated with depressed mood scores.

Regarding the fifth aim, the above affective memory biases were found on patients, irrespective of whether they had sustained focal damage to the ventromedial prefrontal cortex (VMFC) or not.

Thus, overall, when type of memory was taken into account, an enhanced frequency of 'memories' with affective content among confabulations was found in participants, relative to their 'true' memories (Fig 5.2). This was the case whether the patients' underlying pathology included focal involvement of the VMFC or not (Fig 5.3a&b). Within memories with an affective load, the majority of confabulations were rated as more pleasant when the judges were allowed to contrast the content of these confabulations with the 'real' information they had replaced (Fig 5.1) (compare Fotopoulou, 2010; Fotopoulou et al, 2004, 2008b). When rated at 'face value', confabulations and genuinely remembered memories contained similar proportions of pleasant ratings. In other words, irrespective of method used, some confabulations were evaluated as 'unpleasant' (compare Schnider, 2008; Metcalf et al, 2010), and a high proportion of confabulations were of 'neutral' valence.

In summary present findings indicated: (i) an *affective* (but not necessarily positive) bias, which was significantly more pronounced among the confabulations; (ii) the same affective bias on memories irrespective of whether or not the participants' MRI or CT brain scans revealed focal pathology involving the VMFC; and (iii) a high proportion of neutral or 'generic' memories.

It has been suggested that confabulations preserve a positive self-image in the context of the patients' unpleasant reality, which may include a depressed mood-state (Fotopoulou et al., 2008b; Turnbull et al., 2004a). The current study's participants reported a significantly higher proportion of affective confabulations, relative to true memories but these affective confabulations were not necessarily pleasant. Similarly, Metcalf et al (2010) have recently

reported that the personal biases in confabulation are not universally pleasant. Instead they suggested these biases were specific to the individual and served the function of preserving adherence with past and present perceptions of self-identity in the context of change ([Conway & Pleydell-Pearce, 2000](#); [Fotopoulou et al., 2008a](#); [Metcalf et al., 2010](#)). Moreover, whereas Fotopoulou et al. (2008b) found a significant correlation between the pleasantness of the content of confabulations and the severity of depressed mood, in the present study a weak correlation in the opposite direction was obtained both for confabulated and true memories. If this finding were to be replicated, it would suggest that the presence of unpleasant content in confabulations tends to be associated with more severe depressed mood, consistent with the possibility that memories may be mood-congruent. However, the present findings suggest that the contribution of depressed mood to the content of confabulation is likely to be only subtle and not necessarily specific to confabulations (compare Metcalf et al., 2010). Furthermore, previous findings have indicated a significant association between elated mood and both the appearance and the clinical course of confabulation (see chapters 3 and 4 in this thesis), and a significantly higher proportion of affective confabulations relative to true memories were reported by the present sample. Therefore, taken together these findings would indicate that affective state (perhaps irrespective of direction) may be an important factor in confabulation formation.

Turner et al. ([Turner et al., 2008b](#)) have acknowledged that the precise relationship between dysfunction in the VMFC and confabulation remains unclear, but they suggested a couple of possibilities. One was that the VMFC is responsible for integrating cognitive processes with emotional markers that bias

decision-making at a pre-conscious level, and in particular the ‘feeling of rightness’ (Gilboa et al., 2006). The other was that this region is involved in matching events to internal predictions (Turner et al., 2008b). Similarly Schnider hypothesised that the orbitofrontal cortex (OFC) may function as a “generic outcome monitoring system” in the production of memories (Schnider, 2008). In the present investigation, patients showed spontaneous confabulations, and 83.3% of the sample had acted upon their confabulations. However, of those with MRI or CT scans available, only 47.6% showed focal pathology within the VMFC, suggesting that this may not be necessary for the appearance of spontaneous confabulation. Moreover, there was no significant difference between the VMFC and non-VMFC subgroups in terms of the affective bias among the confabulations.

Consistent with other studies, a high proportion of neutral confabulations was found in the current study (Dalla Barba & Boissé, 2010; Metcalf et al, 2010). Burgess and McNeil (1999) and Metcalf et al (2010) argued that faulty memory specification mechanisms result in ‘generic’ confabulations being produced. These represent the most salient elements from the person’s past experiences, emotions and goals. Dalla Barba & Boissé (2010; Dalla Barba et al., 1997) have argued confabulators draw on the most stable elements of their memories, which refer primarily to general habits or patterns of behaviour, rather than the less stable memories of specific events (Dalla Barba, 2009; Kopelman, 2010). Gilboa et al (2006) also proposed that schema about the self (or self-identity) are the most stable elements of autobiographical memory. Memories consistent with these are likely to be accepted as true with excessive confidence, and these generic memories can be nuanced by personal biases. Findings from the

present investigation are consistent with an interpretation of confabulations as preserving adherence with past and present perceptions of self-identity in the context of change ([Conway & Pleydell-Pearce, 2000](#); [Fotopoulou et al., 2008a](#); [Metcalf et al., 2010](#)).

In conclusion, current results showed an enhanced proportion of 'memories' with affective content amongst confabulations, relative to 'true' memories. This affective bias occurred in patients irrespective of whether there was focal pathology within the VMFC. An enhanced effect of pleasant confabulations was found when they were contrasted with the 'real' information they had replaced; however it was not present when confabulations were rated at 'face value' and compared with genuinely remembered memories. Many confabulations had either neutral or unpleasant content and, in this respect, it was interesting that there was some evidence of mood congruency within the confabulations. Whilst there may be a fundamental deficit in trace specification or verification ([Kopelman, 1999, 2010](#)) which underlies confabulation, the present results indicate an affective influence on the content of confabulation, possibly nuanced by the person's concept of self and his/her mood state at the time of the confabulation. Some, but not all, confabulations contain pleasant content.

Chapter 6

General Discussion

The present programme of studies sought to investigate mood, insight and the cognitive correlates of the presence and clinical course of confabulation. Related to this, affective biases in the content of confabulated and true memories were also examined.

As part of the present programme of studies 24 confabulating brain injured amnesic patients, 11 non-confabulating brain injured amnesic controls and 6 healthy participants were assessed in terms of confabulation, temporal context confusion (TCC), insight, mood and background cognitive measures. First, differences between the 3 groups of participants on measures of confabulation, TCC and mood were explored. Second, differences between the two brain injured groups on insight and background cognitive measures were investigated. Thirdly, concurrent associates of the presence of confabulation were examined.

Confabulating participants were followed up over 9 months. They were re-assessed 3 months after the initial assessment and also 6 months later. In the first instance, changes in participants' performance on confabulation, TCC, insight, mood and cognitive measures over time were examined. Secondly, the relative value of TCC, mood and insight as predictors of the clinical course of confabulation was investigated.

In addition, the affective content of confabulating participants' false and true memories was examined. Two independent judges rated participants' responses to the Dalla Barba interview and the Autobiographical Memory Interview (AMI) – episodic schedule for pleasantness. First the proportion of answers with *affective* content (pleasant or unpleasant) among the confabulated and the true memories was examined. Second, the proportion of confabulations with *pleasant* content was examined in relation to: a) the 'real' facts they had replaced and b) 'true' memories correctly remembered. Third, the association between participants' mood scores and the affective load of memories (confabulated and true) was investigated. Fourth, the effects of focal ventromedial prefrontal cortex pathology (VMFC) on confabulated and true memories' affective biases were examined.

6.1. Summary of results

Participants were selected on the basis of presence or absence of spontaneous confabulation, and therefore their diagnoses were varied. Most patients had suffered either hypoxic or traumatic brain damage. Other diagnoses included: subarachnoid haemorrhage, Wernicke-Korsakoff syndrome, cerebral infection and tumour. 10 confabulating participants had sustained focal ventromedial prefrontal cortex pathology (VMFC), and 11 sustained either generalised atrophy or focal pathology that did not involve the VMFC. Of the confabulating group, 20 out of 24 had been observed to act on their false memories. Non-confabulating brain injured controls were matched to the experimental group in terms of memory function, severity of neurological deficits, age and time

elapsed since diagnosis. Healthy controls were matched to the experimental group on age and level of education.

Background cognitive tests

Both groups of brain injured participants performed within similar ranges of function on background cognitive tests; and for the confabulating group cognitive functioning remained relatively stable over the 9 months follow-up. At the point of inclusion to the study both groups had suffered a decline from a premorbid average to a borderline level of cognitive functioning. At the last follow-up confabulating patients' general reasoning had improved, although it still fell within the low average range. Speed of processing also improved mildly between assessments, from an initial 5th to the 10th percentile at the last follow-up. On the other hand, a range of executive functions remained below the 10th percentile over the 3 assessments.

In terms of memory, anterograde memory function fell below the 5th percentile in both groups, and for the confabulating group it remained at that level over the 3 assessments. Autobiographical Memory Interview (AMI) scores showed that both groups recalled recent personal events significantly less accurately than either childhood or young adulthood events. However, these scores also showed a significant difference between the two groups, indicating that the confabulating group recalled autobiographical events with less accuracy than the non-confabulating group. Confabulating participants' recall for recent and childhood memories on this test improved over time (albeit not significantly). These findings are consistent with accounts that propose confabulators draw on

the most stable elements of their memories, that refer to well established patterns of behaviour, rather than on the less stable memories of specific events ([Dalla Barba et al., 1997](#); [Dalla Barba, 2009](#); [Dalla Barba and Boisse, 2010](#); [Kopelman, 2010](#)).

Only one other background measure showed significant differences between the two groups: the Cahill measure of memory for emotional *non-personal* material. Scores on this task indicated that confabulating participants recalled significantly less emotional non-autobiographical material than non-confabulating participants. Both groups were equally able to quantify the affective content of the stimuli; therefore confabulators' pattern of performance on this test could not be due to generalised emotional dysregulation ([compare Metcalf et al., 2010](#)). The pattern of performance shown by confabulating patients on this task is relatively rare, given that a robust enhanced effect of emotional material on memory has been found in patients diagnosed with amnesia, brain injury and even Alzheimer dementia ([Adolphs et al., 1997](#); [Hamann et al., 1997](#); [Kazui et al., 2000](#)). This enhanced effect of memory for emotional material has previously been found to be absent only in patients with bilateral amygdala damage. This has been interpreted as lack of appropriate "experiencing" of emotion in external stimuli ([Adolphs et al., 1997](#)). No previous longitudinal data exist on this task. However, the present confabulating group showed significant improvements over time, indicating that the enhanced effect of emotional material on memory was recovered over time in line with improvements on confabulation.

Confabulations

Regarding the rate of confabulations, the current results showed that the Dalla Barba confabulation interview confirmed the clinical classification of participants in the experimental group, who reported a significantly greater proportion of confabulations than both control groups. This was true both for episodic and personal semantic confabulations. It was also found that confabulations reported by the experimental group decreased significantly over time. This was true for proportion of confabulations overall, and for episodic confabulations in particular.

Regarding the content of confabulations, most of the confabulations examined were judged to have an affective load (either pleasant or unpleasant), whereas this enhanced affective bias was absent in 'true' memories. This pattern of affective bias was present irrespective of whether participants had sustained focal VMFC pathology or not. Furthermore, among confabulations with an affective load, there was an enhanced frequency of pleasant content specifically when confabulations were contrasted with the 'real' facts they had replaced. However, when confabulations were rated at 'face value' and compared with 'true' memories, similar proportions of pleasant content were found among the confabulated and 'true' memories with an affective load.

Experimental measures

In terms of Temporal Context Confusion (TCC), most confabulating patients (but not all) performed considerably worse than healthy participants on TCC,

thereby partially replicating Schnider et al.'s (1996) results. However, in contrast with these authors' findings, performance on TCC showed poor discrimination between confabulating and non-confabulating brain injured amnesic patients. Similarly in partial replication of the work by Schnider et al. (Schnider et al., 2000a), the present longitudinal results showed that confabulating participants' performance on this task did indeed improve in line with improvements on confabulatory behaviour (albeit not significantly in the current sample).

The present confabulating group was also found to have significantly less insight into their condition and their general well-being than the non-confabulating brain injured group. However, after correction for multiple comparisons this difference merely approximated significance. More importantly, level of insight was found to be one of the two concurrent associates that predicted the presence of confabulation with high sensitivity and specificity. Present results indicated that with a cut of achieving specificity of 82%, sensitivity of the proposed model of predictors (i.e.: level of awareness and elated mood) would be 78%. In addition, self-reported levels of insight improved significantly over time in line with improvements on confabulation scores.

Self-reported mood scores indicated that participants did not experience clinically significant levels of elated or depressed mood. Nevertheless, confabulating participants reported near-significant levels of elated mood relative to non-confabulating brain injured amnesic controls. More importantly, the level of self-reported elated mood was found to be one of the two concurrent associates (alongside awareness of difficulties) that predicted the presence of

confabulation with high sensitivity and specificity. Initial levels of elated mood predicted the clinical course of confabulation, and the predictive value of elated mood was strongest for the slope of change on episodic confabulation scores. The level of elated mood experienced by the confabulating group decreased over time (albeit not significantly).

Self-reported depressed mood scores did not show significant differences between the 3 groups of participants; neither did they change significantly over time. A weak correlation between depressed mood scores and affective content of confabulated and true memories was found. If replicated, this finding would suggest that both types of memory tended to be mood congruent.

In summary results from the current programme of studies showed (i) partial replication of Schnider's findings regarding the role of TCC in the appearance and clinical course of confabulation; (ii) a previously unreported role of insight in the appearance and clinical course of confabulation; (iii) a previously unreported role of elated mood in the prediction of the presence and clinical course of confabulation; and (iv) that affect may be a contributory factor in confabulation formation.

6.2. The role of TCC in the appearance and clinical course of confabulation

Schnider and colleagues had claimed that TCC was the only correlate of both the presence and clinical course of confabulation ([Schnider et al., 2000a](#)). Temporal Context Confusion (TCC) is described as an inability to filter out

memories that do not belong to ongoing reality ([Schnider, 2003](#)). Results from the current study partially replicated the work by Schnider and colleagues. 71% of the present confabulators scored above the cut-off point that would index confabulation according to Schnider and colleagues, and all healthy controls scored below this point. In this way the present results constitute a partial replication of Schnider's previous findings ([Schnider et al., 1996](#)).

However, contrary to Schnider's findings, 7 confabulating participants scored below the critical cut-off point. In addition, non-confabulating brain injured amnesic participants' scores were evenly distributed across both sides of the critical cut-off point (figure 3.2). This indicated that performance on the TCC task did not always discriminate between confabulating and non-confabulating amnesic patients. Current non-confabulating brain injured participants' performance on this task was similar to that of the anterior communicating artery aneurysm (ACoA) control group reported by Gilboa et al. ([Gilboa et al., 2006](#)). This may have been due to the severity of executive dysfunction experienced by both control groups. In Gilboa et al.'s ([2006](#)) study, performance on executive and memory tests did not distinguish between confabulating and non-confabulating ACoA participants, most of whom performed below average. Equally, in the present study, confabulating and non-confabulating participants obtained similar scores on executive tests, and these fell below the 10th percentile. On the basis of their results, Gilboa et al. concluded that TCC may be sensitive to confabulation but it is not specific to this condition. The current results would support this conclusion.

Regarding the course of confabulation, very few longitudinal studies exist. Schnider et al. (2000a) measured memory, executive and TCC performance and found that TCC was the only measure that paralleled recovery from confabulation across participants. The present findings provide partial support for this claim. Confabulating participants' performance on the TCC task did indeed improve over time in line with improvements on confabulation measures. However this improvement on TCC was not statistically significant, whereas recovery from confabulation was significant in the current sample. Related to this Schnider (2008, pg. 251) himself has described individual cases where TCC did not parallel confabulation recovery. Critics of Schnider's hypotheses have argued that TCC may be necessary but it is not sufficient for the appearance of confabulation (Gilboa, 2010). Similarly the present results would suggest that TCC may have played a part in the recovery from confabulation for some patients, but it was not critical to the recovery of confabulation in the present sample.

6.3. The role of insight in the appearance and clinical course of confabulation

The role of insight in the appearance and clinical course of confabulation has not been formally studied previously. The present findings provide evidence that insight into memory difficulties and well-being may be an important factor in the appearance and clinical course of confabulation. Results from the current study showed that poor insight was a strong correlate of the presence of confabulation and also that it improved significantly in line with recovery from confabulation. These results are consistent with previous observations

indicating that recovery from confabulation is accompanied by improved awareness of deficits (Feinberg and Roane, 1997; Mercer et al., 1977). Indeed there is some evidence that clinical interventions aimed at improving awareness and self-monitoring have improved confabulation in clinical samples, although authors did not explain why the treatment worked (DeLuca, 2009; Dayus and Van, 2000).

Although insight or awareness runs as an overarching theme throughout most explanatory models of confabulation, an explicit account of the nature of its relationship with confabulation has not been put forward. Several authors have argued that confabulation is caused by deficits experiencing ongoing reality, and as these lift, patients recover from confabulation (Schnider, 2008; Dalla Barba and Boisse, 2010). More specifically, Feinberg and Roane (1997) described confabulation as “an alteration in ... relatedness to the environment.” (Feinberg and Roane, 1997). Somewhat similarly, absence of enhanced retrieval for non-personal affective information (as measured by the Cahill task) has been attributed to a lack of appropriate “experiencing” of emotion in *external* stimuli (Tranel et al., 2006; Adolphs et al., 1997). Results from the current study showed that this effect was indeed absent in confabulating participants, but returned in line with improvements on confabulation. In other words, present results showed that over time awareness of difficulties improved significantly, and so did ability to experience emotion in external stimuli; at the same time confabulations decreased significantly in the current sample. In this way, present findings would be consistent with explanations that propose that confabulation is accompanied by a disconnection between internal and external

reality, although the precise nature of such disconnection and the direction of the causal relationship are yet unknown.

One possible explanation for the results obtained in the current investigation is that the disconnection experienced by confabulating participants is caused by dysfunction in the amygdala ([Tranel et al., 2006](#); [Adolphs et al., 1997](#)). Brain imaging information in the current sample did not allow determination of amygdala damage on confabulating patients' performance on the Cahill and insight tasks, but would be necessary in order to verify this hypothesis. But why should confabulating patients have reduced ability for experiencing emotion from external stimuli? A simple explanation would be that dysfunction in a key attentional gateway could result in a 'blindspot' for externally generated information. This attentional gateway has been located in BA10, and when intact, it has been found to be responsible for switching attention between internally and externally generated stimuli as and when required ([Burgess et al., 2007a](#)). In order to test this hypothesis, confabulating participants' function in BA10 would need to be examined while considering internally versus externally generated information. Alternatively, Conway ([Conway et al., 1996](#)) proposed that during normal memory reconstruction personal importance and affect may be assigned to memories at the same time. In their study, recall of false memories was accompanied by a lack of integration between these processes. The present confabulating participants showed reduced insight, which has been interpreted by some authors in terms of a disconnection from the external world. Therefore, affect and personal importance may not be assigned in the usual way in confabulating participants. In this connection, one possibility is that in an effort to maintain self-coherence, (false) memories which support important

goals and self-concepts may have increased affective intensity and accessibility (Conway, 2005); in contrast, other memories less personally relevant for confabulating participants (e.g. those generated by the Cahill task) may be assigned less affective intensity and accessibility. In order to test this hypothesis, current results would need to be replicated taking care to measure recalled memories in terms of personal relevance and intensity of affect.

In practical terms, if current results were to be replicated, the insight measure employed in this study would need to be validated. Moreover, further investigations into the effectiveness of interventions designed to improve awareness of difficulties, which are reported to have reduced confabulations would be extremely valuable for clinical practice; these would require larger samples and more stringent controlled conditions than those reported in the literature.

Thus, results from the current study provide evidence that awareness of memory difficulties and general well-being may be an important factor in the appearance and clinical course of confabulations. However, further study would be required in order to determine the specific role that insight plays in the recovery from confabulation.

6.4. The role of affect in the prediction of presence and clinical course of confabulation

As discussed above, current findings indicated confabulating participants may experience deficits integrating internally generated thoughts and memories with

external feedback. In this context mood state may be an important factor in the appearance and clinical course of confabulation. Indeed self-reported elated mood predicted both the presence of confabulation and its clinical course. Current findings also showed that slightly elated mood decreased in line with a reduction of confabulation over time.

Results from the current investigation would be partially consistent with findings that indicate that elated mood modulates memory in psychiatric populations ([Corwin et al., 1990](#)). In these studies, elated mood was linked to a liberal bias in patients' responses to recognition memory tasks; this bias disappeared when patients recovered from the underlying mood disorder.

The present findings support explanations that propose that mood and emotional mechanisms may modulate the appearance and clinical course of confabulations in the context of weak memory and monitoring mechanisms ([Conway, 2005](#); [Fotopoulou, 2010](#); [Metcalf et al., 2010](#); [Gilboa, 2010](#)). However, the effects of mood on the cognitive mechanisms underlying confabulation has not been specified. In this connection two 'core' mechanisms have been proposed to be critical in the appearance of confabulation: (i) a 'preconscious Feeling of Rightness (FOR)', which refers to an early sense that the memory retrieved may be correct, and (ii) 'Control' mechanisms, which regulate the quantity and accuracy of memories reported ([Gilboa, 2010](#)). According to Gilboa (2010) breakdown of FOR monitoring processes may cause patients to erroneously accept confabulated memories with high confidence. On the other hand, confabulators' exaggerated willingness to report false memories may be due in part to breakdown of Control mechanisms. Within this framework, one

possible explanation for the current findings is that elated mood may promote an exaggerated sense of confidence in confabulated memories. In order to investigate this hypothesis future studies would need to include a measure of patients' confidence in their reported memories. Another possibility is that elated mood may exacerbate confabulators' willingness to report (false) memories. In order to verify this hypothesis future investigations would need to include a free narrative task where the participants would have control over whether or not to report (false) memories. Thus, further experimentation would be needed in order to determine the effect of elated mood on the 'core' mechanisms underlying confabulation: FOR and Control processes.

In addition, previous authors have seldom commented on recovery from confabulation ([Schnider, 2008](#); [Nahum et al., 2010](#)). Schnider has found that dopamine antagonists sometimes reduce confabulation ([Schnider, 2008](#)). Corwin et al. found that beta-blockers reversed elated mood disorders and an associated excessive willingness to guess during memory recognition ([Corwin et al., 1990](#)). Therefore, if the present findings were replicated, they may have clinical implications. For example it is possible that reducing initial levels of elated mood may accelerate the rate of recovery from confabulation. Randomised controlled methods would be required in order to verify this hypothesis, and to examine the effectiveness of the suggested drug treatments on reduction of confabulation.

In summary, the current results indicated that elated mood may have a contributory and previously unreported role in the appearance and recovery from confabulation.

6.5. The role of affect in confabulation formation

As discussed above, mood state may have an important role in the appearance and clinical course of confabulations. Related to this several authors have shown that emotional factors influence confabulation formation. Identity and personal goals may determine the content of confabulations (Conway, 2005; Fotopoulou, 2010). Further to this, current findings provide evidence that affect may be an important factor in confabulation formation.

Fotopoulou has found that independent raters consistently judged confabulations to be more pleasant than the 'real' facts they had replaced. She also found that pleasant confabulations were associated with depressed mood (Fotopoulou, 2010). In view of these findings several authors have proposed that personal identity and related goals may exert an exaggerated influence on the content of confabulation when memory and executive functions are disrupted (Conway, 2005; Fotopoulou, 2010). Therefore, the overwhelmingly pleasant content of confabulations in those studies was interpreted in terms of the influence on memory of a self-preserving tendency to maintain a positive image, in the context of patients' unpleasant reality and associated depressed mood (Fotopoulou, 2010). This was partially supported by current findings. Among the memories with affective content, a significantly higher proportion of pleasant content was found on confabulations in the current study when judges were allowed to contrast them with the 'real' facts they had replaced.

However, in contrast with Fotopoulou's findings, results from the current study showed there was an *affective* (but not necessarily positive) bias in the content of confabulations relative to that of true memories. Also in contrast with previous findings, current results indicated that all memories studied (both true and false) had a tendency to be mood congruent. Metcalf has argued that a pleasant or self-enhancing bias on confabulation is not universal (Metcalf et al., 2010). She found that only confabulations about recent events had a significant pleasant bias in content. Some confabulations had unpleasant content. In this connection, Fotopoulou has argued that negative affect in confabulations may be linked to islands of awareness of deficits or unpleasant past events (Fotopoulou, 2010). Also of note a large proportion of neutral confabulations and true memories were reported by the present sample. This is consistent with previous findings (Metcalf et al., 2010; Dalla Barba and Boisse, 2010). Relative to this, it has been proposed that 'generic' memories or 'input templates' are used as starting values when constructing memories. They appear to be influenced by affect and by premorbid concepts of self-identity, and perhaps help patients cope with a changing reality. Deficits in memory trace specification and verification would lead to these 'generic' memories being incorrectly reported in place of the required specific events (Metcalf et al., 2010; Burgess and Shallice, 1996). Observational evidence has indicated that these 'habit' confabulations may be nuanced by mood state (Metcalf et al., 2010); they are likely to be selected over others for several reasons. Firstly, being over-rehearsed, their memory traces may simply be more resilient to amnesia than less stable traces of specific events (Dalla Barba and Boisse, 2010; Kopelman, 2010). Second, memories that are highly consistent with self-identity are likely

to be a) more emotionally salient, and b) accepted as true with excessive confidence ([Gilboa et al., 2006](#); [Conway, 2005](#); [Fotopoulou, 2010](#)).

In summary, the results from the current study indicated an affective influence in confabulation formation. The current findings support explanations of confabulation that propose that in the context of trace specification and verification deficits; confabulators draw on the more stable elements of memory, thereby reporting 'generic' or 'habit' confabulations. These appear to be nuanced by self-identity concepts and affect.

6.6. Conclusions

In conclusion, the present programme of studies presented the first prospective longitudinal examination of the clinical course of confabulation in a relatively large sample. Several comprehensive models of confabulation attempt to explain the complex interaction between the various functional systems that underlie accurate autobiographical recollection: medial temporal memory formation structures, frontal attentional control processes, and awareness and emotion regulatory systems possibly linked to the amygdala ([Kopelman, 2002, 2010](#); [Gilboa et al., 2006](#); [Metcalf et al., 2010](#)). The present study investigated some of these factors. Results overall supported the notion that autobiographical recall is supported by a diverse range of cognitive and emotional processes.

Current findings partially replicated Schnider's results indicating that TCC was sensitive to confabulation and paralleled the recovery from this condition. In

contrast, TCC was found to be neither specific to nor predictive of the presence and clinical course of confabulation in the current sample. The current study indicated that elated mood state may have a contributory and previously unreported role on the appearance, clinical course and formation of confabulations. The present findings also indicated that awareness of memory difficulties and general well-being may also play a contributory and previously unreported part in the appearance and clinical course of confabulations. Further study would be required to determine the specific roles of these factors on confabulation. The present findings highlight the need for current explanatory models of confabulation to include a 'dynamic' dimension to account for the clinical course of this condition.

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Appendix 2.1

Dalla Barba confabulation battery

(Dalla Barba et al. (1993); Kopelman, Ng & Van den Brouke (1997); M. Kopelman, pers. comm.)

Code:

Date:

(?)=Examiner's request for clarification or detail

DK=don't know

boldface=confabulation

italics=correct information

A) PERSONAL SEMANTIC MEMORY:

1. what is your name?
2. how old are you?
3. what is your date of birth?
4. where were you born?
5. when were you admitted to the hospital?
6. what is your present address?
7. are your parents alive?
8. why are you in hospital?
9. are you married?
10.do you have any children?
11.how many children do you have?
12.how old are your children?
13.how old were you when you had your first child?
14.what are your children's first names?
15.what are your children's birth dates?
16.what are your parents' first names?
17.what was your father's job?
18.do you have any brothers or sisters?

19. what are your brothers' first names?
--

20. have you seen me before?

B) EPISODIC MEMORY:

1. what did you eat for dinner yesterday?

2. what did you do yesterday?

3. who did you meet this morning?

4. how did you spend last Christmas?

5. what did you do for your last birthday?
--

6. do you remember the last time you went to see a doctor?
--

7. do you remember the last time you went to the cinema?
--

8. do you remember the last time you went to the restaurant?
--

9. do you remember the day of your admission to this hospital?
--

10. what were you doing the day Princess Diana was killed? (31.8.97)
--

11. do you remember your first day at junior school?
--

12. do you remember your first child's birth?

13. do you remember your wedding? (or a wedding you attended)

14. do you remember your last day at school?
--

15. do you remember when you were admitted to the hospital for the first time?
--

C) ORIENTATION IN TIME AND PLACE:

1. what year are we?

2. what season are we?

3. what month are we?

4. what is the date?

5. what day of the week are we?

6. what time is it?

7. what city are we in?
8. where are we now?
9. in which country are we now?
10.on which floor are we located?

D) GENERAL SEMANTIC MEMORY:

1. when did World War I start?
2. when did World War II start?
3. what happened to President Kennedy?
4. who is Montgomery?
5. who is Dennis Compton? (cricketer)
6. who is George Best (footballer)?
7. who is Winston Churchill?
8. who is Marilyn Monroe?
9. who is the Prime Minister?
10.what happened in Kuwait in 1989?
11.what happened to Robert Maxwell?
12.what happened to the Pope recently?
13.what happened to Princess Grace of Monaco?
14.what happened in Northern Ireland in 1969?
15.what happened in the Falklands?

E) I DON'T KNOW – SEMANTIC:

1. Who won the football championship/league in 1982?
2. Who won the Nobel Prize for literature in 1980?
3. Who won gold medal in the men's Epée competition for the last two Olympics?
4. Who was Foreign Secretary in 1965?
5. Who is president of Mexico?
6. How many Renault cars were sold in 1985?
7. Which team is world champion in fencing?
8. Which state abolished the monarchy in 1973?
9. In what form of employment was Marilyn Monroe's father?
10. Who arrived in London in April 1982?

F) I DON'T KNOW – EPISODIC:

1. What did you do 13 th March 1985?
2. What colour was the tie of the doctor who examined you last time?
3. What did you do Christmas day 1957?
4. What did you do on your 25 th birthday?
5. What were you doing last month?
6. What were you doing last year?
7. On your last visit to the bank, what was the clerk wearing?
8. What did your school teacher say the first time you saw her?
9. When you last took the bus, how was the person next to you dressed?
10. On Tuesday of last week, what did you eat for supper?

Appendix 2.2

Insight Questionnaire

Code:

Date:

Questions	Answers
a) Why are you here? b) Has anything happened to cause you to be in hospital?	Score best answer: a) or b) <div>0 1 2</div> <div>correct DK error</div>
a) Is there anything wrong with your head or brain? b) Is it true that XXX time ago you had a XXX that caused damage to your brain?	Score best answer: a) or b) <div>0 1 2</div> <div>correct DK error</div> <div>Yes so they tell me no</div>
Are you able to think as clearly as usual?	<div>0 1 2</div> <div>correct DK error</div>
Does your memory let you down regularly? / is your memory particularly bad at the moment?	<div>0 1 2</div> <div>correct DK error</div>
Is it true ...that you are perfectly fit to go home and look after yourself?	<div>0 1 2</div> <div>correct DK error</div>
...that you've never felt better?	<div>0 1 2</div> <div>correct DK error</div>
...that you're quite/very ill?	<div>0 1 2</div> <div>correct DK error</div>

0 = a true representation of why the person is in hospital

1 = answer that reflects doubt/uncertainty about what has happened or about current intellectual competency (eg: they tell me... but I don't remember; I don't know, can't remember, not sure...)

2 = answer that reflects contradiction in either the reason for hospitalisation or the degree of intellectual competency according to clinicians

Appendix 2.3

Supplementary WASI analysis

As part of the clinical characterisation of our sample, we measured cognitive function was measured and IQ differences between confabulating and non-confabulating brain injured participants were examined. For this purpose the WASI was employed in the majority of cases. However this was not possible for a minority of patients.

One confabulating patient was not able to complete WASI tasks and was given the Rivermead Progressive Matrices – Colour version ([Raven et al., 1984](#)) instead.

A further 8 participants had already been administered the WAIS-III for clinical purposes less than three months before they were included in this study. The WASI could not be administered to these patients because their scores would have been inflated due to practice effects. Instead their IQ was calculated in one of the following three ways: a) either from the full WAIS-III battery (2 confabulators and 1 control), or b) from partial WAIS-III prorated scores (1 confabulator), or c) from WAIS-III short form scores (3 confabulators and 1 control).

The data reported in study 1 (chapter 3 of this thesis) included IQ scores derived from all the above measures. No evidence of IQ differences was found between confabulating and non-confabulating brain injured participants.

In order to check whether the use of slightly different IQ measures had introduced any biases on our results only scores derived from WASI were selected for the present analysis. Differences in IQ between confabulating and non-confabulating participants in this subsample were then examined.

A one-way ANOVA with group as the independent factor (confabulating or not confabulating), and IQ score as the dependent variable showed no significant IQ differences between the two patient groups ($F(1,24)= 1.432$, $p= 0.243$).

Table 1 shows descriptive statistics of WASI-derived IQ scores for both groups.

Table 1. Mean and standard deviation of WASI-derived IQ scores for confabulating and non-confabulating brain injured participants

Descriptives WASI-only cases								
IQ1					95% Confidence Interval for Mean			
			Std.	Std.	Lower Bound	Upper Bound	Minimum	Maximum
	N	Mean	Deviation	Error				
BI control	9	74.33	10.665	3.555	66.14	82.53	55	94
confabulator	17	80.18	12.391	3.005	73.81	86.55	59	98
Total	26	78.15	11.946	2.343	73.33	82.98	55	98

In conclusion, data from the current sample reported in chapter 3 of this study showed that confabulating and non-confabulating brain injured participants did not differ in cognitive ability at the time of inclusion to the study. However this data included slightly different IQ measures on a minority of the patients studied. Analysis of differences on the subsample whose IQ was derived

exclusively from the WASI showed the same results as the data presented in chapter 3. Therefore it was concluded that the use of different measures of IQ for a minority of participants had not introduced a significant bias in the results of the current study.